THIRTY-NINTH ANNUAL REPORT

OF THE

SECRETARY

OF THE

STATE BOARD OF AGRICULTURE

OF THE

STATE OF MICHIGAN

AND

THIRTEENTH ANNUAL REPORT

OF THE

EXPERIMENT STATION

FROM

JULY 1, 1899, TO JUNE 30, 1900

BY AUTHORITY

1900.
WYNKOOP HALLENBECK CRAWFORD CO. OF LANSING, MICH.
STATE PRINTERS.

REPORT OF THE SECRETARY

OF THE

STATE BOARD OF AGRICULTURE

AGRICULTURAL COLLEGE, }
July 1, 1900. }

TO HONORABLE HAZEN S. PINGREE,

Governor of the State of Michigan:

SIR—I have the honor to submit to you herewith, as required by statute, the accompanying report for the fiscal year ending June 30, 1900, with supplementary papers.

Very respectfully,

ARTHUR C. BIRD,

Secretary of the State Board of Agriculture.

STATE BOARD OF AGRICULTURE.

	Term Expires.
THOMAS F. MARSTON, Bay City,	1903
President of the Board.	
FRANKLIN WELLS, Constantine,	1901
CHAS. J. MONROE, South Haven,	1901
EDWARD P. ALLEN, Ypsilanti,	1903
HOLLISTER F. MARSH, Allegan,	1905
L. WHITNEY WATKINS, Manchester,	1905
HAZEN S. PINGREE, Governor of the State,	*Ex-Officio.*
JONATHAN L. SNYDER, Pres. of the College,	*Ex-Officio.*

A. C. BIRD, Agricultural College, Secretary.
BENJAMIN F. DAVIS, Lansing, Treasurer.

STANDING COMMITTEES.

The President of the Board is *ex-officio* a member of each of the Standing Committees.

Finance,	H. F. Marsh, C. J. Monroe.
Farm Management,	Franklin Wells, L. W. Watkins.
Botany and Horticulture,	L. W. Watkins, C. J. Monroe.
Buildings and Property,	H. F. Marsh, Franklin Wells.
Employees,	E. P. Allen, H. F. Marsh, J. L. Snyder.
Farmers' Institutes,	C. J. Monroe, Franklin Wells.
Mechanical Department,	H. F. Marsh, L. W. Watkins.
Military and Athletics,	L. W. Watkins, E. P. Allen.
College Land Grant,	Franklin Wells, C. J. Monroe.
State Weather Service,	C. J. Monroe, L. W. Watkins.
Experiment Station,	L. W. Watkins, E. P. Allen.
Library,	E. P. Allen, H. F. Marsh.
Women's Department,	C. J. Monroe, E. P. Allen.
Chemical and Other Academic Departments not Otherwise Provided for,	Franklin Wells, H. F. Marsh.

STATE AGRICULTURAL COLLEGE.

(Under Control of the State Board of Agriculture.)

FACULTY AND OTHER OFFICERS.

JONATHAN L. SNYDER, Ph. D., President; [a b c] Feb. 25, '96.

ROBERT C. KEDZIE, M. A., M. D., D. Sc., LL. D., Professor of Chemistry and Curator of the Chemical Laboratory; [a b c] Feb. 25, '63.

WM. J. BEAL, A. M., M. S., Ph. D., Professor of Botany and Forestry and Curator of the Botanical Museum; [a b] July 9, '70, [c] Feb. 22, '71.

LEVI R. TAFT, M. S., Professor of Horticulture and Landscape Gardening, and Superintendent of the Horticultural Department; [a b c] Aug. 1, '88.

HOWARD EDWARDS, M. A., LL. D., Professor of English Literature and Modern Languages; [a b c] Aug. 25, '90.

HERMAN K. VEDDER, C. E., Professor of Mathematics and Civil Engineering; [a b c] Sept. 15, '91.

CLINTON D. SMITH, M. S., Dean of Short Courses, College Extension Lecturer, and Superintendent of Institutes, [a b] Sept. 1, '93; [c] July 1, '99.

CHAS. L. WEIL, S. B., Professor of Mechanical Engineering and Director of the Mechanical Department; [a b c] Sept. 1, '93.

WALTER B. BARROWS, S. B., Professor of Zoölogy and Physiology, and Curator of the General Museum; [a b c] Feb. 15, '94.

GEORGE A. WATERMAN, B. S., M. D. C., Professor of Veterinary Science; [a b c] Sept. 1, '98.

MAUD RYLAND KELLER, A. M., Dean of the Women's Department; [a b c] Sept. 1, '98.

ARTHUR C. BIRD, B. S., M. Agr., Secretary; [a b c] Feb. 22, '99.

HERBERT W. MUMFORD, B. S., Professor of Agriculture and Superintendent of Farm; [a] Sept., '95; [b] Dec. 1, '96; [c] July 1, '99.

FRANK S. KEDZIE, M. S., Adjunct Professor of Chemistry; [a b] Sept. 15, '80; [c] Jan 1, '91.

PHILIP B. WOODWORTH, B. S., M. E., Assistant Professor of Physics; [a b] May 22, '87; [c] Aug. 7, '89; [d] Sept. 1, '99.

William S. Holdsworth, B. S., Assistant Professor of Drawing; [a] Feb. 22, '81; [b] Aug. 22, '87; [c] Jan. 1, '90.

Wilbur O. Hedrick, M. S., Assistant Professor of History and Political Economy; [a b] August 24, '91; [c] September 1, 93.

Warren Babcock, B. S., Assistant Professor of Mathematics; [a b] June 30, '91; [c] Sept. 1, '93.

Charles F. Wheeler, B. S., Assistant Professor of Botany; [a b] Mar. 1, '90; [c] June 1, '93.

Georgiana Blunt, Ph. M., Assistant Professor of English and Modern Languages; [a b c] Sept. 1, '98.

U. P. Hedrick, M. S., Assistant Professor of Horticulture; [a b c] Sept. 1, '99.

Joseph A. Jeffery, B. S. Agr., Assistant Professor of Agriculture; [a b c] Sept. 1, '99.

Martin D. Atkins, A. B., Assistant Professor of Physics and Electrical Engineering; [a b c] Sept. 1, '99.

Alexander W. Moseley, S. B., Assistant Professor of Mechanical Engineering; [a b c] Jan. 1, '00; [d] June 30, '00.

Charles E. Marshall, Ph. B., Assistant Professor of Bacteriology and Hygiene; [a b c] Sept. 1, '00.

Charles O. Bemies, Director of Physical Culture; [a b c] Sept. 1, '99.

Mrs. Linda E. Landon, Librarian; [a b c] Aug. 24, '91.

A. L. Westcott, B. M. E., Instructor in Mechanical Engineering; [a b c] June 1, '93; [d] Sept. 1, '99.

Dick J. Crosby, B. S., Instructor in English; [a b c] Sept. 1, '93; [d] Jan. 1, '00.

Burton O. Longyear, Instructor in Botany; [a b c] Feb. 15, '94.

Gordon H. True, B. S., Instructor in Dairying; [a b c] Sept. 1, '94; [d] Sept. 1, '99.

H. E. Smith, Instructor in Mechanics; [a b c] Sept. 1, 96; [d] June 30, '00.

Rufus H. Pettit, B. S. Agr., Instructor in Zoölogy; [a b c] Feb. 1, '97.

Mrs. Maud A. Marshall, Instructor in Music; [a b c] Sept. 1, '97.

Mrs. Jennie L. K. Haner, Instructor in Sewing; [a b c] Sept. 1, '97.

William O. Beal, B, S., M. A., Instructor in Mathematics; [a b c] Sept. 1, '97.

Carrie L. Holt, Instructor in Drawing; [a b c] Sept. 1, '98.

Ellen R. Rushmore, Instructor in Domestic Science; [a b c] Sept. 1, '98; [d] Oct. 1, '99.

Frank V. Warren, B. S., Instructor in Mathematics; [a b c] Sept. 1, '98; [d] Sept. 1, '99.

Chace Newman, Instructor in Mechanical Drawing, and Assistant in Woodwork; [a b c] Dec. 1, '92.

J. J. Ferguson, B. S. Agr., Instructor in Dairying; [a b c] Sept. 1, '99.

BELLE C. CROWE, Instructor in Domestic Science; [a b c] Oct. 1, '99.

E. SYLVESTER KING, Instructor in English; Jan. 1, '00.

FRED C. KENNEY, Cashier; [a b] Sept. 18, '95; [c] Oct. 1, '97.

THOMAS GUNSON, Foreman of Greenhouse; [a b] April 1, '91; [c] Sept. 1, '91.

CHARLES A. WOOD, Foreman of the Horticultural Department; [a b c] May 1, '98; [d] June 30, '00.

CHARLES H. ALVORD, B. S., Foreman of the Farm; [a b c] April 1, '98; [d] Sept. 1, '99.

W. R. BRADFORD, Foreman of the Wood Shop; [a b c] Nov. 1, '97.

W. S. LEONARD, Foreman of the Machine Shop; [a b c] Sept. 1, '96.

E. C. BAKER, Foreman of the Foundry; [a b c] Nov. 1, '97.

E. R. BLAIR, Foreman of Farm; [a b c] Sept. 1, '99.

L. F. NEWELL, Engineer, [a b c] Jan. 1, '98.

EDWIN S. GOOD, Clerk to President; [a b c] July 15, '96; [d] Sept. 1, '99.

B. A. FAUNCE, Clerk to President; [a b c] Sept. 1, '99.

a First appointment.
b Present appointment.
c Present title.
d Resignation.

AGRICULTURAL EXPERIMENT STATION

OF THE

MICHIGAN AGRICULTURAL COLLEGE.

(Under the control of the State Board of Agriculture.)

STATION COUNCIL.

CLINTON D. SMITH, M. S., - Director.
J. D. TOWAR, B. S., - Agriculturist.
L. R. TAFT, M. S., - Horticulturist.
ROB'T C. KEDZIE, M. A., M. D., D. Sc., LL. D., - - Chemist.
CHAS. E. MARSHALL, Ph. B., - - Bacteriologist and Hygienist.
A. C. BIRD, B. S., M. Ag., Sec. and Treas.
J. L. SNYDER, Ph. D., Pres., *Ex-officio* Member.

ADVISORY AND ASSISTANT STAFF.

H. W. MUMFORD, B. S., - - Experimenter in Live Stock.
M. L. DEAN, - Assist. in Horticulture.
L. H. VAN WORMER, B. S., - - - Assistant in Chemistry.
L. S. MUNSON, B. S.,[a] Assist. Chemistry.
GEO. A. WATERMAN, V. S. Consulting Veterinarian.
W. B. BARROWS, S. B.,[a] Consulting Zoölogist.
CHAS. F. WHEELER, B. S., - - Consulting Botanist.
R. H. PETTIT, B. S. A., - - - Consulting Entomologist.
S. H. FULTON, B. S., In charge of South Haven Sub-Station.
MRS. L. E. LANDON, - - Librarian.
J. J. FERGUSON, B. S. Agr., - - Dairyman.

SUB-STATIONS.

Grayling, Crawford county, 80 acres deeded.
South Haven, Van Buren county, 10 acres rented; 5 acres deeded; Local Agent, S. H. Fulton, B. S.
Chatham, Alger county, 160 acres deeded.

STATE WEATHER SERVICE.

(Under the control of the State Board of Agriculture.)

OFFICERS OF THE SERVICE.

DIRECTOR, - - - - - C. F. Schneider, U. S. Weather Service, Lansing.

STANDING COMMITTEE IN CHARGE.

HON. L. WHITNEY WATKINS, - - - - - - - - - - Manchester.
HON. EDWARD P. ALLEN, - - - - - - - - - - Ypsilanti.

(a) Resigned to take effect Sept. 1, '99.

ACCOUNTS OF THE STATE AGRICULTURAL COLLEGE.

FOR THE YEAR ENDING JUNE 30, 1900.

SECRETARY'S FINANCIAL REPORT.

			Dr.	Cr.
July 1, 1899.	To cash on hand (State account)		$575 52	
" 1, 1899.	By college treasurer (overdraft)		....	$3,307 02
" 1, 1899.	By balance due on nursery inspection		....	95 00
June 30, 1900.	To special appropriation receipts:			
	From State Treasurer	$72,500 00		
	From United States Treasurer	15,000 00		
	From institution	3,215 96		
			90,715 96	
June 30, 1900.	By special appropriation disbursements		....	83,011 96
" 30, 1900.	To current account receipts:			
	From State Treasurer	$60,000 00		
	From United States Treasurer	25,000 00		
	From institution	*30,321 91		
			115,321 91	
June 30, 1900.	By current account disbursements		....	106,256 98
" 30, 1900.	By cash on deposit, college treasurer		....	11,261 53
" 30, 1900.	By cash on hand		....	2,680 90
			$206,613 39	$206,613 39

TABLE NO. 1.—*Tabular Exhibit of Secretary's Report.*

Name of account.	Balance sheet, July 1, 1899.		Transactions July 1, 1899, to June 30, 1900.		Balance sheet, June 30, 1900.	
	Dr.	Cr.	Dr.	Cr.	Dr.	Cr.
Cash	$575 52	....	$2,105 38	....	$2,680 90	....
College treasurer*	....	$3,307 02	14,568 55	....	11,261 53	....
Special appropriation	....	851 91	$3,011 96	$90,715 96	....	$8,555 94
General current	3,678 44	....	106,256 98	115,321 91	....	5,386 49
Nursery license	....	95 00	95 00	....	....	....
Totals	$4,253 96	$4,253 96	$206,037 87	$206,037 87	$13,942 43	$13,942 43

* Treasurer's statement is greater July 1, 1899, by $9,573.14, warrants outstanding less credits by remittance in transit of $2,896.17, and June 30, 1900, $9,288.14.

TREASURER'S ACCOUNT.

	Dr.	Cr.
Balance on hand July 1, 1899	$1,754 60	
Receipts from State Treasurer and secretary	203,530 63	
Interest on deposits, 11 months at 2½ per cent	314 25	
Warrants paid July 1, 1899, to June 30, 1900	....	$185,049 81
Balance on hand June 30, 1900	....	20,549 67
	$205,599 48	$205,599 48

TABLE No. 2.—*Statement of special appropriation account for fiscal year July 1, 1899, to June 30, 1900.*

Name of appropriation.	Balance of account July 1, 1899.		Receipts during fiscal year.		Total available.	Total expended.	Balance of account June 30, 1900.	
	Dr.	Cr.	From State treasury.	From institution.			Dr.	Cr.
Experiment station		$895 66	$15,000 00	$2,464 16	$18,359 82	$17,872 38		$487 44
Weather service	$63 20		1,000 00	9 32	946 12	936 01		10 11
Repairs—Buildings		19 48	5,000 00		5,019 48	5,019 48		
Institute			5,500 00		5,500 00	5,500 00		
Student labor			2,500 00		2,500 00	2,500 00		
Women's building			50,000 00	5 88	50,005 88	42,263 45		7,742 43
Heating and furnishing—Women's building			1,000 00		1,000 00	2,128 13	$1,128 13	
Farm barn			3,000 00	64 60	3,064 60	2,286 64		777 96
Fire escapes			500 00		500 00	500 00		
Repairs—Heating			2,500 00		2,500 00	2,500 00		
Nursery license and inspection				672 00	672 00	462 00		210 00
Upper Peninsula experiment station			1,500 00		1,500 00	877 05		622 95
Dairy building						166 82	166 82	
Balance	851 94						8,555 94	
Totals	$915 14	$915 14	$87,500 00	$3,215 96	$91,567 90	$83,011 96	$9,850 89	$9,850 89

TABLE No. 3.—*Current account July 1, 1899, to June 30, 1900.*

On account of—	Dr. To disbursements.	Cr. By receipts.
U. S. Treasurer, Eleventh annual payment under act of congress of August 30, 1890		$25,000 00
State Treasurer interest on proceeds of sales of U. S. land grant		60,000 00
Salaries paid	$45,794 07	
Farm department	9,369 43	7,911 13
Horticultural department	4,437 50	2,165 48
Mechanical department	3,742 55	1,002 51
Heating department	10,943 51	1,639 02
Cleaning department	1,981 11	86 98
Lighting department	1,885 49	962 17
Office	1,234 52	101 54
Advertising	1,720 98	
M. A. C. Record	818 33	745 77
Special courses	1,920 03	900 39
Academic department	7,628 11	2,345 87
Contingent building	9,791 56	11,650 03
Miscellaneous	4,989 79	811 02
	$106,256 98	$115,321 91
Balance at beginning of period, July 1, 1899	3,678 44	
Balance at close of period, June 30, 1900	5,386 49	
	$115,321 91	$115,321 91

TABLE No. 4.—*Experiment station account, July 1, 1899, to June 30, 1900.*

On account of—	Dr. To disbursements.	Cr. By receipts.
Balance from last fiscal year		$895 66
U. S. Treasurer for fiscal year		15,000 00
Fertilizer license fees		1,620 00
Salaries paid	$9,514 53	
Farm department	3,042 95	438 43
Horticultural department	628 19	
Chemical department	642 40	
Botanical department	10 75	
Zoölogical department	42 33	
Veterinary department	42 66	
Library	213 19	
Sundry	795 20	148 21
Secretary's office	585 50	
South Haven sub station	1,647 76	257 52
Apiary	87 23	
Bacteriological	619 69	
Balance on hand at close of fiscal year	487 44	
	$18,359 82	$18,359 82

TABLE NO. 5.—*Regular employees and salaries.*

Officers.	Rate per year.	Classification. Current.	Classification. Experim't station.	Other sources.	
President	$3,200 00	$3,200 00			Dwelling.
Professor chemistry	2,000 00	1,700 00	$300 00		"
" botany	1,800 00	1,800 00			"
" horticulture	1,800 00	400 00	1,400 00		"
" English	1,800 00	1,800 00			"
" mathematics	1,800 00	1,800 00			"
" college extension lecturer, director of experiment station	2,300 00	400 00	1,300 00	$600 00	"
" mechanical engineering	1,800 00	1,800 00			"
" zoölogy	1,800 00	1,800 00			"
" veterinary science	1,600 00	1,300 00	300 00		
Dean of women's department	1,100 00	1,100 00			Room.
Secretary	1,800 00	300 00	500 00	1,000 00	Dwelling.
Professor of agriculture	1,800 00	1,600 00	200 00		
Adjunct professor of chemistry	1,800 00	1,800 00			
Assistant professor of drawing	1,250 00	1,250 00			Rooms.
Professor history and political economy	900 00	900 00			"
Assistant professor mathematics	1,000 00	1,000 00			"
" " botany	1,000 00	500 00	500 00		"
" " English	900 00	900 00			Room.
" " horticulture	1,200 00	1,200 00			
" " agriculture	1,200 00	1,200 00			
" " physics	1,400 00	1,400 00			
" " mechanical engineering	1,300 00	1,300 00			
Director of physical culture	1,000 00	1,000 00			Rooms.
Librarian	725 00	605 00	120 00		"
Instructor in botany	550 00	550 00			
" " mechanical engineering	700 00	700 00			
" " zoölogy	1,000 00	500 00	500 00		Dwelling.
" " music	500 00	500 00			
" " sewing	600 00	600 00			Room.
" " bacteriology	1,200 00	200 00	1,000 00		
" " mathematics	600 00	600 00			
" " drawing	400 00	400 00			
" " mechanical drawing	550 00	550 00			
" " dairying	850 00	637 50	212 50		
" " domestic science	864 00	864 00			Room.
" " English	750 00	750 00			
Foreman of greenhouse	800 00	800 00			Dwelling.
" " machine shop	850 00	850 00			
" " wood shop	600 00	600 00			
" " foundry	600 00	600 00			
Cashier	1,000 00	800 00	200 00		
Foreman of gardens	500 00	500 00			Dwelling.
" " college farm	500 00	500 00			"
Clerk to president	550 00	550 00			
Engineer	600 00	600 00			Dwelling.
Bookkeeper	500 00	400 00	100 00		
Clerk to secretary	420 00	320 00	100 00		
" " mechanical department	420 00	420 00			
Assistant horticulturalist	700 00	100 00	600 00		
Agriculturalist	1,500 00		1,500 00		
Assistant in chemistry	450 00		450 00		
Stenographer to director of experiment station	420 00		210 00	210 00	
Assistant in greenhouse	360 00	360 00			
Night watchman	420 00	420 00			
Totals	$58,029 00	$46,726 50	$9,492 50	$1,810 00	

TABLE NO. 6.—*Detailed statement of Legislative*

Object.	Total.	1899.	1897.	1895.	1893.
Buildings	$351,325 00	Women's dormitory... $83,000 Heating and furnishing dormitory........ 12,000 Dairy building........ 15,000 Farm barn........ 4,000 Heating apparatus........ 2,500 Fire escapes........ 500 $117,000 00	Electric light plant..... $5,000 Bath room, Abbot hall.... 200 $5,200 00	Closets........ $3,000 00	Equip. botanical lab..... $1,000 Foundry........ 1,500 Hospital........ 2,500 $5,000 00
General account	466,655 57	....	....	....	....
Repairs	87,388 60	10,000 00	12,000 00	12,000 00	13,500 00
Library	25,055 00	....	....	....	2,000 00
Farm	26,175 64	....	....	....	900 00
Garden	11,991 00	....	....	....	200 00
Greenhouse	2,765 00	....	....	....	....
Botany	5,331 00	....	....	....	....
Chemistry	13,955 00	....	....	....	....
Zoölogy	10,296 00	....	....	....	225 00
Veterinary	2,586 00	....	....	....	....
Mathematics	6,090 00	....	....	....	500 00
Mechanical	15,200 00	....	....	....	....
Steam and water	20,832 00	....	....	....	....
Institutes	41,800 00	11,000 00	11,000 00	10,000 00	4,000 00
Student labor	58,000 00	5,000 00	5,000 00	8,000 00	8,000 00
Weather service	22,937 50	2,000 00	2,000 00	2,000 00	....
Sundry	8,960 00	....	....	....	3,400 00
Totals	$1,173,343 31	$145,000 00	$35,200 00	$35,000 00	$37,725 00
Annual tax on each $1,000 of assessment	† $0.035	$0.0656	$0.0155	$0.0155	$0.01⅔
*Aggregate tax to date on each $1,000 of assessment	....	$2.2301	$2.0989	$2.0679	$2.0369
Assessed valuation of State in millions of dollars	....	1,105.10	1,105.10	1,130	1,130

* Counting only taxes actually levied and omitting land grants.
† Average.

appropriations to the State Agricultural College.

1891.	1889.	1887.	1885.	1883.	1881.	1879.	1877.	1855-75.
Botanical laboratory....$10,000 Heating apparatus...... 1,950 Greenhouse........... 4,500	Agricultural laboratory.$8,000 Sundry.............. 1,800	Howard terrace........$10,000 Abbot hall............ 10,000 Horticultural labt'y.... 5,000 Mechanical labt'y...... 3,000 Bridge, etc............ 2,100	Mechanical laboratory...$7,800 Veterinary laboratory... 5,400 Armory.............. 5,000 One dwelling.......... 4,000	Boiler house..........$5,000 One dwelling.......... 3,000	Library..............$25,000 Chemical labt'y add.... 6,000 Barns............... 2,775	Botanical laboratory....$6,000 One dwelling.......... 3,000	Wells hall...........$25,000	Williams hall, 1869.....$30,000 Chemical labt'y, 1871... 10,000 Greenhouse, 1873....... 8,000 Three dwellings........ 18,000 Bridges.............. 800
$16,450 00	$9,800 00	$30,100 00	$22,200 00	$8,000 00	$33,775 00	$9,000 00	$25,000 00	$66,800 00
....	....	....	....	16,770 00	14,498 00	9,943 60	12,300 00	413,143 97
7,800 00	5,000 00	1,400 00	3,147 00	6,720 00	1,576 00	1,290 00	3,691 60	9,264 00
2,000 00	3,000 00	3,000 00	3,300 00	3,125 00	3,000 00	2,000 00	1,190 00	2,440 00
2,100 00	800 00	2,815 00	4,810 00	3,389 00	4,175 00	4,016 64	2,400 00	1,670 00
570 00	500 00	1,250 00	432 00	1,342 00	3,220 00	2,810 00	947 00	720 00
530 00	600 00	340 00	1,295 00	....	....	....	....	....
500 00	1,000 00	800 00	800 00	2,231 00	....	....	....	....
500 00	1,500 00	2,000 00	2,500 00	1,000 00	3,000 00	1,000 00	1,380 00	1,075 00
700 00	1,500 00	1,500 00	1,500 00	1,945 00	1,000 00	800 00	480 00	646 00
100 00	200 00	200 00	2,086 00	....	....	....	....	....
200 00	475 00	600 00	450 00	700 00	2,020 00	1,020 00	125 00	....
1,500 00	3,200 00	4,000 00	5,200 00	1,000 00	300 00	....	....	....
2,045 00	2,920 00	7,500 00	1,400 00	4,267 00	....	....	....	2,700 00
1,500 00	800 00	600 00	600 00	600 00	600 00	600 00	500 00	....
8,000 00	8,000 00	8,000 00	8,000 00	....	....	....	....	....
....	8,350 00	8,587 50	....	....	....	....	....	....
1,400 00	500 00	2,100 00	....	....	....	600 00	660 00	300 00
$45,895 00	$48,145 00	$74,792 50	$57,720 00	$51,089 00	$67,164 00	$33,080 24	$48,673 60	$498,758 97
$0.02	$0.02½	$0.04	$0.03⅓	$0.04 1-7	$0.04 1-7	$0.02⅗	$0.04	$0.0747
$2.0036	$1.963	$1.912	$1.833	$1,7657	$1.7026	$1.6197	$1.5672	$1.4407
1,330	945.15	945.45	810	810	810	630	630	137 to 630

TABLE No. 7.—*Income of the State Agricultural College from all outside sources from the date of its foundation to the present time.*

Year.	From State Legislature. For current expenses.	From State Legislature. For special purposes.	From U. S. Congress. Land sales salt spring and swamp land grants.	From U. S. Congress. Morrill act of 1862, interest from land grant and trespass.	From U. S. Congress. Hatch act of 1887, experiment station.	From U. S. Congress. Morrill act of 1890, supplementary endowment	Total.
1855			$56,320 00				$56,320 00
1856							
1857	$40,000 00						40,000 00
1858							
1859	37,500 00						37,500 00
1860							
1861	6,500 00		152 25				6,652 25
1862	10,000 00		218 97				10,218 97
1863	9,000 00		407 80				9,407 80
1864	9,000 00		726 09				9,726 09
1865	15,000 00		1,156 61				16,156 61
1866	15,000 00		1,094 27				16,094 27
1867	20,000 00		7,608 38				27,608 38
1868	20,000 00		592 49				20,592 49
1869	20,000 00	$30,000 00	17,559 00	$58 96			67,617 96
1870	20,000 00		1,320 02	2,720 93			24,040 95
1871	18,250 00	10,500 00	4,135 72	3,785 84			36,671 56
1872	18,250 00	3,000 00	217 05	7,175 65			28,642 70
1873	21,796 00	15,602 00	10 13	11,059 06			48,467 19
1874	13,000 00	15,602 00	150 13	14,061 98			42,814 11
1875	7,638 00	7,755 50	144 53	14,446 14			29,984 17
1876	7,638 00	6,755 50	1,773 09	16,830 17			32,996 76
1877	6,150 00	30,686 80	979 06	15,172 86			52,988 72
1878	6,150 00	5,686 80	826 60	15,807 09			28,470 49
1879	4,971 80	16,068 32	712 22	16,978 22			38,730 56
1880	4,971 80	7,068 32	797 55	17,837 24			30,674 91
1881	7,249 00	43,720 50	461 95	20,935 25			72,366 70
1882	7,249 00	8,945 50	358 46	22,507 45			39,060 41
1883	8,385 00	23,793 00	391 95	30,749 60			63,319 55
1884	8,385 00	10,526 00	1,259 90	27,909 72			48,080 62
1885		35,103 00	187 50	29,770 40			65,060 90
1886		22,617 00		30,461 04			53,078 04
1887		* 44,040 00	† 198 20	† 24,611 37			68,849 57
1888		30,752 50	144 20	32,406 60	$15,000 00		78,303 30
1889		* 20,973 00	10 50	31,322 69	15,000 00		67,306 19
1890		* 27,172 00	238 50	32,360 64	15,000 00	$15,000 00	89,771 14
1891		22,947 50	37 38	34,750 54	15,000 00	16,000 00	88,735 42
1892		22,947 50	137 38	34,948 12	15,000 00	17,000 00	90,033 00
1893		18,862 50	10 50	37,927 04	15,000 00	18,000 00	89,800 04
1894		18,862 50	433 59	44,527 26	15,000 00	19,000 00	97,823 35
1895		‡ 19,000 00	10 50	45,301 85	15,000 00	20,000 00	99,312 35
1896		‡ 16,000 00		44,037 25	15,000 00	21,000 00	96,037 25
1897		‖ 17,700 00		43,779 54	15,000 00	22,000 00	98,479 54
1898		¶ 17,500 00		45,190 17	15,000 00	23,000 00	100,690 17
1899‖‖		§ 8,750 00	705 00	50,402 90	15,000 00	24,000 00	98,857 90
1900		72,500 00	175 00	75,452 09	15,000 00	25,000 00	188,127 09
Totals	$362,083 60	$651,437 74	$101,662 47	$875,285 66	$195,000 00	$220,000 00	$2,405,469 47

* Including appropriations for weather service.
† October 1, 1886, to June 30, 1887, nine months.
‡ Including $5,000 for institutes and $1,000 for weather service.
§ Including $2,750 for institutes and $500 for weather service.
‖ Including $5,500 for institutes and $1,000 for weather service.
¶ Including $5,500 for institutes and $1,000 for weather service.
‖‖ To June 30.

SUMMARY OF INVENTORY, JUNE 30, 1900.

College farm and park, 671 acres @ $70		$46,970 00
Buildings—		
Library and museum, built 1881	$22,000 00	
College hall, built 1856	17,000 00	
Williams hall, built 1869	30,000 00	
Wells hall, built 1877	20,000 00	
Abbot hall, built 1888, add. in 1896	15,000 00	
Chemical laboratory, built 1871, south end add. '81	18,000 00	
Machine shops and foundry, 1885, so. end add. '87	15,000 00	
Veterinary laboratory, built 1885	5,000 00	
Horticultural laboratory, built 1888	6,000 00	
Agricultural laboratory, built 1889, imp. 1897	7,500 00	
Botanical laboratory, built 1892	10,000 00	
Armory, built 1885	6,000 00	
Greenhouse and stable, built 1873, 1879; rebuilt '92	6,000 00	
Greenhouse, experiment, built 1889	1,300 00	
Boiler house and chimney, built 1893–4	4,000 00	
President's and two frame dwellings, built 1874	12,000 00	
Four brick dwellings, built 1857	10,000 00	
Two brick dwellings, built 1879 and 1884	6,000 00	
One frame dwelling, built 1885	3,500 00	
Howard terrace dwelling, built 1888	13,000 00	
Farm house dwelling, built 1869	2,000 00	
Herdsman's dwelling, built 1867	400 00	
Ten barns at professors' houses	2,000 00	
Horticultural barn and shed, built 1868, 1875, 1887	1,200 00	
Cattle barn and shed, built 1862	1,500 00	
Sheep barn, built 1865	1,000 00	
Horse barn, built 1871	1,000 00	
Pig barn, built 1871	1,000 00	
Corn barn, built 1878	400 00	
Grain barn, built 1881	1,600 00	
Horse sheds, built 1894	200 00	
Tool barn, built 1881	1,000 00	
Barn, built 1884	800 00	
Brick work shop, built 1857	500 00	
Observatory, built 1880	150 00	
Bath house and fittings, built 1889	400 00	
Ice house, 1879	100 00	
Paint shop, built 1879	150 00	
Bee house, 1884, remodeled dwelling, 1893	700 00	
Hospital, 1894	3,000 00	
Poultry building and yards, 1894	625 00	
Dairy barn, built 1897	800 00	
Waiting room street car terminus, built 1897	80 00	
Street car track and fixtures, 600 ft., built 1897	360 00	
Lumber shed, mechanical department	250 00	
Silo	210 00	
Coal shed, built 1899	700 00	
Woman's building, built 1900	91,000 00	
Farm barn, built 1900	4,000 00	
		344,425 00
Iron bridge over Cedar river, built 1888		1,500 00
Water works and steam works—		
Artesian well and connections, sunk '87, 343 ft. deep	$1,000 00	
Artesian well and connections, sunk '99, 345 ft. deep	700 00	
Fire pump, 1883, $650; tank pump, 1881, $200	850 00	
Three hose carts and 4 nozzles, bought 1883-'88-'00	124 00	
2,378 ft. wood pipe, 6 in., laid 1883-87; 2,623 ft. wood pipe, 4 in., laid 1883-87; 662 ft. wood pipe, 3 in., laid 1883-87	1,531 00	
	$4,205 00	
Carried forward		$392,895 00

Brought forward	$4,205 00	$392,895 00
Water works and steam works—*Continued:*		
One thousand feet fire hose	320 00	
Water tank and heater, built 1883	400 00	
Thirteen fire hydrants in place, built 1883-87	400 00	
Valves, fittings and connections, laid 1883-87	500 00	
Four boilers, 4 ft. x 12 ft., built 1881	600 00	
Two boilers 5 ft. x 12 ft., built 1887	700 00	
Two small pumps, 1881-91	200 00	
Underground steam piping, laid 1882	2,500 00	
Miscellaneous tools and stock	235 64	
One water purifier	325 00	
Two water meters	20 00	
Injector	20 00	
Main steam pipe, 1892	300 00	
Safety valve on water main	15 00	
One pile hammer	10 00	
Six service boxes, in place 1893	8 00	
Six lawn hydrants, in place 1894	25 00	
Five-inch exhaust head	10 00	
Three fire hydrants, 1898	18 00	
1,200 ft. 3 in. iron water main, 1898	160 00	
Steel benching, put in in 1895	265 00	
College hall steam main, 1898	1,500 00	
Ag. Lab. steam line, 1897	1,000 00	
1 L. & D. boiler feed pump	135 00	
2 Kokomo telephones	28 00	
1 electric line and cons. to Williams Hall tank	3 00	
		13,902 64
Farm Department—		
Feed	$215 90	
Cattle	3,475 00	
Sheep, 70 head	1,054 00	
Horses	700 00	
Swine	293 00	
Tools, implements, scales, windmills, etc	1,687 87	
Class rooms, office and farm house equipment	2,321 09	
Experiment station	1,575 06	
Growing crops, estimated	1,100 80	
Dairy room	942 93	
		13,365 65
Horticultural Department—		
Animals in Zoo	$185 00	
Pruning tools	13 10	
Teams, harness, etc	642 50	
Heavy tools	411 85	
Compost and manures	50 00	
Carpenters' tools	29 45	
Ice tools	37 50	
Office	124 75	
Class room	786 25	
Tool room	252 25	
Greenhouse plants	2,454 48	
Vegetable garden	45 50	
Laboratory, furniture, etc	40 20	
Experiment station	837 25	
Greenhouse tools	273 45	
Work room	7 00	
		6,190 53
Mechanical Department—		
Class room and office equipment	$6,528 13	
Machine shop	7,954 78	
Wood shop	2,622 85	
Blacksmith shop and foundry	1,831 87	
		18,937 63
Carried forward		$445,291 45

Brought forward		$445,291 45
Chemical Department—		
Furniture, apparatus and chemicals	$11,769 54	
Experiment station	1,818 83	
		13,588 37
Botanical Department—		
Herbarium	$6,850 08	
Museum	900 75	
Office class apparatus and garden tools, etc	3,770 50	
		11,521 33
Mathematical and Engineering Department—		
Surveying instruments	$1,993 10	
Telescope and accessories	839 75	
Furniture, apparatus, etc	861 07	
Photographic material	50 40	
Office furniture	311 60	
		4,055 92
Library, exclusive of experiment station library—		
19,862 books and pamphlets	$37,154 00	
Sunday school books	130 00	
Portrait and pictures	1,020 00	
Furniture	1,113 10	
		39,417 10
Physical Department—Fixtures and apparatus	$6,275 33	
Veterinary laboratory—Museum furniture and apparatus	1,796 40	
Zoölogical Department—Furniture and apparatus	1,872 90	
General Museum—Collections and cases	17,512 50	
College hall furniture and English department	987 75	
Drawing	1,013 75	
Public parlor furniture, $50.80; hospital furniture, $29.20	80 00	
President's office	754 73	
Secretary's office	1,514 22	
Armory—Furniture and equipment	697 90	
Abbot hall—Furniture and fixtures	2,138 59	
State Board of Agriculture rooms	341 69	
Farmers' institute	232 11	
Athletic apparatus	600 60	
Electric light plant, complete	5,000 00	
One dynamo at agricultural laboratory	280 00	
Advertising	67 00	
Bacteriological Department	738 80	
		41,904 27
Experiment station		24,942 73
Total		$580,721 17
United States property held in trust—		
Two 3-in rifled guns and equipments	$1,573 55	
250 Springfield rifles, complete	3,750 00	
250 rifle equipments	665 00	
Reloading tools, chests, tarpaulins, etc	83 55	
		$6,072 10

SUMMARY OF EXPERIMENT STATION INVENTORY.

Lands donated to the Station—		
80 acres at Grayling, fenced and improved at cost	$1,000 00	
5 acres at South Haven, fenced and improved	1,000 00	
		$2,000 00
Buildings—		
Experiment feed barn	$800 00	
Horticultural laboratory, experimental rooms	1,200 00	
Veterinary laboratory, experimental rooms	250 00	
Apiary	600 00	
Forcing houses, $1,500.00–$600.00	2,100 00	
Feed mill	100 00	
Sub faculty building	3,000 00	
Seed room	980 00	
Poultry house and yards	625 00	
Dairy room in agricultural laboratory	250 00	
Storage barn	600 00	
Cold storage fruit house	1,500 00	
		12,005 00
Library and office of secretary—		
1,795 books	$3,227 60	
Furniture and mailing list in type	255 00	
		3,482 60
Farm Department—		
Office	$333 65	
Tools and implements	508 06	
Poultry	290 05	
Stock	108 50	
Fertilizers and grains	116 30	
		1,356 56
Horticultural Department—		
Office, furniture, implements, etc	$637 25	
One team	200 00	
		837 25
Chemical Department—		
Porcelain	$26 54	
Glassware	96 45	
Furniture and fixtures	180 10	
Chemicals	37 30	
Apparatus	1,478 44	
		1,818 83
Botanical Department—		
Microscopes and accessories	$316 88	
Furniture and sundry apparatus	216 11	
		532 99
Bacteriological Department—		
Instrument and sundry apparatus	$1,892 91	
Chemicals	310 00	
		2,202 91
Zoölogical Department—		
Microscopes, cases, etc		706 59
		$24,942 73

DEPARTMENT REPORTS.

REPORT OF THE PRESIDENT.

To the Honorable State Board of Agriculture:

I have the honor to submit herewith my annual report as president of the Michigan State Agricultural College for the year ending June 30, 1900.

While some of the departments were overcrowded, yet on the whole very satisfactory work was done. There was no serious interruption during the year. Faculty and students were enthusiastic, and worked together with gratifying results.

The attendance was nearly one hundred more than the preceding year. The largest increase was in the Mechanical Department. This was no doubt partially due to the adoption in this department of a five-year course. There is, however, a strong and increasing demand for instruction along mechanical and engineering lines. This feeling is not confined to the cities. It is a notable fact that during the past year a majority of the boys coming from the farm entered one of the mechanical engineering courses. If in the future the College should develop more rapidly along mechanical than agricultural lines, it will be brought about in response to the demand made by the farmers of the State. Today the majority of the bright boys of the country are being educated in city and village high schools. The courses of study in these schools are not such as to keep a boy in sympathy with farm life, and when he enters college he naturally selects a line of study and work that will prepare him for some other pursuit than that of farming. There are also other reasons for the large increase in attendance in the Mechanical Department. The bright boy can see that there is likely to be a great demand for well trained men in mechanical and electrical engineering. Steam and electric power will be utilized to a greater extent in the future, and there will be a constant demand for well trained men in these lines.

The enrollment during the past year was as follows:

Summary.	Fruit.	Cheese.	Creamery.	Live stock.	Sugar Beet.	Agricultural.	Mechanical.	Women's.	Totals.
Post-graduates						7	......	......	7
Class of '00						10	12	3	25
Class of '01						36	27	9	72
Class of '02						52	58	27	137
Class of '03						88	129	45	262
Special students						24	6	27	57
Special short course students	6	17	26	17	5	71	......	......	71
Totals						288	232	111	631
Deduct names repeated						......	......	......	4
Final total						......	......	......	627

Commencement week passed off very pleasantly this year. The Baccalaureate Sermon was delivered in the Armory on the evening of June 10 to a large audience by the Rev. Nehemiah Boynton, D. D., of Detroit.

The triennial alumni reunion was held on the 14th. One hundred fifty alumni returned to their Alma Mater and seemed to fully enjoy the occasion.

Commencement exercises were held on the 15th in the Armory. An address was made by a graduate of each department. The orator of the day was the Hon. Booker T. Washington, principal of the Tuskegee Normal and Industrial Institute, Alabama. The room was packed and the address was much appreciated by everybody.

The names and addresses of those graduating are as follows:

Name.	Postoffice.	County.
Appleyard, Louis L., m	Lansing	Ingham.
Bale, Charles W., m	Vermontville	Eaton.
Ball, William, m	Grand Rapids	Kent.
Bodourian, Angtrain G	Ismid	Turkey.
Chamberlin, Harry L., m	Lansing	Ingham.
Cimmer, Alice M., w	Highland	Oakland.
Clark, Homer B., m	Coldwater	Branch.
Fuller, George B., m	Agricultural College	Ingham.
Gunnison, Hugh B., m	DeWitt	Clinton.
Hilton, Charles H	Benton Harbor	Berrien.
Knechtel, Abraham	Agricultural College	Ingham.
Leipprandt, Charles Wesley	Pigeon	Huron.
Malone, Bertha, w	Lansing	Ingham.
Nevins, Wilfred B., m	Douglas	Allegan.
Parker, Clare H	Grand Blanc	Genesee.
Parks, William T	Pipestone	Berrien.
Ranney, Ellis W	Greenville	Montcalm.

Name.	Postoffice.	County.
Robson, Harriette I., w	Lansing	Ingham.
Spring, Charles H., m	Grand Ledge	Eaton.
Thayer, Paul	Benton Harbor	Berrien.
Thompson, John R., m	Grand Rapids	Kent.
Thompson, Irma G., w	Lansing	Ingham.
Williams, Harbey A	Hoytville	Eaton.

The degree of Master of Agriculture was conferred upon William Caldwell, of the class of '76, and the honorary degree of Master of Science upon the State Superintendent of Public Instruction, the Hon. Jason E. Hammond, of the class of '86.

CHANGES IN FACULTY.

At the close of last year Prof. Philip B. Woodworth, who had charge of the Department of Physics and Mechanical Engineering for twelve years, resigned to accept a position in the Lewis Institute, Chicago. Mr. Woodworth had charge of this department from its inception, and great credit is due him for its systematic and continuous development.

Prof. Martin D. Atkins, a graduate of the U. of M., and a teacher of ten years of successful experience, was elected to fill this position, and has done very acceptable work during the past year.

Prof. Harry P. Gladden, who since 1899 had been connected with the Horticultural Department, first as assistant in experimental work, and later as assistant professor of horticulture, resigned to take effect July 1, 1899. Mr. Gladden gave the College very faithful and efficient service.

Prof. U. P. Hedrick, professor of horticulture in the Utah Agricultural College, was elected to this position and the class-room work of the department placed in his charge.

Mr. A. L. Westcott, instructor in mechanical engineering, resigned on September 6th to accept the professorship of mechanical engineering in the University of Montana. Mr. A. W. Moseley was elected to this vacancy, and the position changed to that of assistant professor of mechanical engineering.

Mr. Gordon H. True, who had very ably filled the position of instructor in dairying for five years, resigned to accept a similar position at a much higher salary in the University of Arizona. Mr. J. J. Ferguson, a graduate of the Guelph Agricultural College, was elected to this position.

Miss Ellen Rushmore, instructor in domestic science, resigned one month after the fall term opened to accept a position in the Long Island State Hospital for the Insane. Miss Belle C. Crowe, who had been a teacher in Pratt Institute, Brooklyn, N. Y., was elected to the position vacated by Miss Rushmore.

On the first of January Mr. Dick J. Crosby, who for nearly seven years had rendered very faithful and valuable service in the English department, resigned to pursue special work in agriculture. This vacancy was filled by the election of Mr. E. Sylvester King, a graduate of the Northwestern University.

The Department of Physical Culture was created at the beginning of last year and Mr. C. O. Bemies placed in charge as director. The work of the new department has moved along pleasantly and bids fair to exercise a beneficent influence on student life at the College in the future.

IMPROVEMENTS.

The improvements at the College during the past year have been many.

Three buildings are now in course of construction and will be ready for occupancy during the next school year.

The Women's Building will cost, when completed with the furnishings, $95,000. It is well constructed of hydraulic re-pressed brick and red sandstone, and has hard wood floors, red oak trimmings, and hard plaster throughout. The heating, plumbing and lighting are of modern design and of first-class quality of material.

In this building are the offices and private rooms of the dean and of the various women instructors; a suite of four pleasant rooms for the Department of Domestic Art; a kitchen laboratory, with adjacent dining room, for classes in cooking; a large recitation room; pleasant parlors; a large dining room, kitchen and serving room on third floor; a two-story gymnasium; music rooms; waiting and reception rooms, toilet and bath rooms; large, well ventilated living rooms for 120 young women.

The Dairy Building is a well constructed brick structure of 64 by 70 feet, two stories high, with basement. In the basement are the store rooms, cold storage, cheese curing room, lockers and wash rooms for students. On the first floor will be found the home dairy room, butter room, cheese room, wash room, and testing room. The second floor is given up to class rooms, offices and laboratories. The cost of this building was $15,000.

The barn was constructed after the model furnished by Mr. Shawver of Bellefontaine, Ohio. It is a two-story barn, 44 by 72 feet, with a wing 40 by 76 feet.

The Pere Marquette Railroad built a track from Trowbridge to the College, a distance of about one and three-fourths miles. The expense to the College was one thousand dollars. This is a very important improvement. The coal for the year, which amounts to nearly three thousand tons, as well as the material for the new buildings, was brought direct to the College Campus. It has also proved very valuable in enabling the different railroads to run their excursion trains to the College without having to depend upon street car service.

Class Entering September, 1899.

	Male.	Female.	Total.
Number entering	229	64	293
Average age	19-8 mo.	20-3 mo.	....
Median age	19	19-7 mo.	....
SCHOOLS PREVIOUSLY ATTENDED:			
High school	169	31	200
District	37	18	55
College	15	6	21
Private	5	2	7
Ferris Industrial School	4	4	8
Not given	1	....	1
ENTERED FRESHMAN CLASS ON:			
High school diploma	78	21	99
Teacher's certificate	13	10	23
Standings from other colleges	12	1	13
Examinations	53	5	58
Age	42	10	52
Eighth grade diploma	17	10	27
SUPPORT WHILE HERE:			
Father	135	36	171
Self	62	14	76
Father and self	14	1	15
Mother	14	9	23
Not given	5	1	6
OCCUPATION OF FATHER:			
Farmer	91	29	120
Dentist	1	....	1
Physician	3	1	4
Mechanic	14	4	18
Lawyer	5	....	5
Clerk	12	2	14
Real estate and insurance	6	1	7
Lumber	5	1	6
Minister	4	....	4
Merchant	13	2	15
Traveling man	6	....	6
Manufacturer	3	2	5
Architect	3	....	3
Civil engineer	2	....	2
Mechanical engineer	4	....	4
Newspaper man	4	....	4
Commission agent	3	1	4
Deceased	21	8	29
Miscellaneous	25	5	30
Not given	5	3	8
PROPOSED OCCUPATION AFTER LEAVING COLLEGE:			
Farming	31	....	31
Mechanical engineering	24	....	24
Electrical engineering	20	....	20
Mechanics	19	....	19
Civil engineering	5	....	5
Mining engineer	2	....	2
Architect	1	....	1
Chemist	3	....	3
Teaching	6	22	28
Physician	3	1	4
Law	2	....	2
Gardening	2	....	2
Dressmaking	....	2	2
Housekeepers	....	4	4
Merchant	2	....	2
Manufacturer	1	....	1
Not fully decided	100	27	127
Not given	8	6	14

Church preference and membership.

	Preference.	Membership.
Methodist	49	35
Congregational	42	16
Presbyterian	15	16
Baptist	21	7
Episcopal	7	6
Lutheran	2	4
Catholic	....	7
Friends	....	4
Church of Christ	1	....
United Brethren	2	....
Universalist	4	....
Christian Scientist	1	....
No church preference	22	....
Not given	11	....

Counties represented in the last freshman class.

Allegan	4	Menominee	2
Alpena	2	Missaukee	3
Antrim	1	Montcalm	2
Arenac	1	Muskegon	1
Barry	1	Montmorency	3
Bay	2	Newaygo	2
Benzie	1	Oakland	14
Berrien	10	Oceana	3
Branch	2	Ogemaw	1
Calhoun	4	Ontonagon	1
Cass	3	Osceola	1
Charlevoix	1	Otsego	2
Clare	1	Ottawa	3
Clinton	5	Presque Isle	2
Eaton	13	Sanilac	3
Emmet	2	Shiawassee	6
Genesee	3	Saginaw	3
Gratiot	3	St. Clair	2
Hillsdale	3	St. Joseph	3
Huron	2	Tuscola	2
Ingham	70	Van Buren	7
Ionia	4	Washtenaw	3
Iosco	1	Wayne	9
Isabella	3	Wexford	1
Jackson	14		
Kalamazoo	5	OTHER STATES REPRESENTED.	
Kalkaska	2		
Kent	11	Indiana	1
Lapeer	2	Illinois	6
Leelanau	3	New Jersey	1
		New York	1
Lenawee	13		
Livingston	4	Ohio	1
Macomb	1	Virginia	1
Manistee	2	Wisconsin	1
Mason	1	Puerto Rico	1

Further information concerning the College may be found in the various department reports in the following pages.

Respectfully submitted,

J. L. SNYDER,

President.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1900.

REPORT OF THE DEPARTMENT OF PRACTICAL AGRICULTURE.

To the President:

SIR—I have the honor to submit the following report of the Department of Practical Agriculture for the year ending June 30, 1900:

The undersigned assumed the duties of Professor of Agriculture and Superintendent of the College Farm at the opening of the year.

As head of the Department of Practical Agriculture our duties have been varied. So far as instruction to the students is concerned we have devoted our attention to giving instruction in animal husbandry as heretofore.

In our stock judging classes at the barns, owing to the large number of students reporting to us for this work, it was necessary to call upon one of our instructors, Mr. Ferguson, to aid in this work. We are pleased to report that Mr. Ferguson's work in this capacity was satisfactory, his previous training and natural bent making him well qualified for the work.

Through the generosity and, we believe, wisdom of the Board of Agriculture, the position of assistant professor of agriculture was created.

Professor J. A. Jeffery, assistant professor of soil physics in the University of Wisconsin, was secured for this place, and we do not hesitate to say that his work has been faithful and efficient. Professor Jeffery has devoted his time to class-room and laboratory work with soils, crops, and farm machinery.

Mr. Gordon H. True, who had been connected with the department as instructor in dairying for five years, resigned to take charge of the work in animal husbandry in the University of Arizona. The place left vacant by his resignation was filled by the appointment of Mr. J. J. Ferguson of Smith's Falls, Ont. In all his work Mr. Ferguson has shown a thorough familiarity with the various phases of dairy work, and his suggestions concerning the plans of the new dairy building have been especially timely.

Mr. Charles Alvord, foreman of the College Farm, resigned in September to accept the position of assistant professor of agriculture in the State of Texas.

Mr. E. R. Blair was elected to fill the vacancy made by the resignation of Mr. Alvord.

It will not be difficult for you to understand that an entire change of employes in this department has made it impossible to execute every phase of our work in the best possible manner. The coming year, with our staff familiar with the details of the work, more efficient work will be rendered.

It is our constant purpose to teach in class room, laboratory and field those things which will be most helpful to our young men when they return to the farm.

We need to increase the amount of dairy work which is given to our regular students. There are other phases of agricultural instruction

which should be introduced, but as the course now stands it is impossible. Agricultural instruction is in a transitional stage, and we should plan not only to keep pace, but also to set the pace of rapid advancement and growth along these lines.

We are striving to make the best possible use of the time allotted to this department. It would be desirable if our agricultural students could enter the regular course better prepared, so that more time during the four years could be devoted to technical agriculture and less time to mathematics and English.

As a member of the State Board of Agriculture, you are already acquainted with the fact that the board authorized the sale of the grade dairy herd, and appropriated the money from such sale for the purchase of specimen sheep.

Considerable time has been spent in the planning of our new dairy barn and our new dairy building, which are now both well under way. These two buildings will add materially to the equipment of this department.

Through the courtesy of the library committee we have been able to place several new agricultural books in the general library, and add some valuable agricultural journals to our periodical list.

To our equipment for the teaching of soil physics we have added the following valuable pieces of apparatus: Whitney's Electrical Bridge, for determining soluble salts in soils; three sets of soil tubes for the study of moisture losses in soil, with different mulchings and cultivations; a complete outfit for determining soil moisture; Tortion balance and Jackson grade level.

We have also prepared an exhibit of soils of various sizes, and typical soils of districts famous for producing special crops.

It is our aim to make the farm, the barns, the stock, and in fact all of the equipment of the Department of Practical Agriculture an object lesson for students and farmers of Michigan, as well as furnishing nature's laboratory for the study of practical agriculture.

Respectfully submitted,
HERBERT W. MUMFORD,
Professor of Agriculture and Superintendent of College Farm.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1900.

REPORT OF THE DEPARTMENT OF HORTICULTURE AND LANDSCAPE GARDENING.

To the President:

SIR—I submit herewith the report of this department for the past year:

The first change in the organization of the department took place soon after the beginning of the year, when U. P. Hedrick, '93, was made assistant professor of horticulture.

CLASS ROOM AND LABORATORY WORK.

During the fall an office in the second story of the Horticultural Laboratory was fitted up for Professor Hedrick, who entered upon his duties with the opening of the College year, Prof. H. P. Gladden having resigned July 1.

The class-room instruction and much of the laboratory work has been under his charge, and the following is his report:

"During the fall term instruction in pomology was given to forty eight students, mostly agricultural juniors, for fourteen weeks, and in pomology and floriculture, one-half term each, to fifteen juniors in the women's course. The subjects were taught by lectures, supplemented in the afternoon of every other day by a study of the different species and varieties of fruits, for the young men, and by work with plants once or twice a week by the young women, during the time floriculture was being taught.

"At the close of the fall term the members of the junior class in the agricultural course elect work in either agriculture or horticulture, to be carried through the remaining terms.

"This year one-half of the class, eighteen in all, elected horticulture. For the first of these elective studies a course in floriculture and winter vegetable gardening was offered in the winter term. A series of lectures was given, supplemented by training in the greenhouse, and by reading in various reference books.

"In the greenhouse each student was given a certain crop to grow, to experiment with, and to thoroughly inform himself upon.

"In the spring term the topic of 'spraying' was considered, two days per week being spent, with Lodeman's 'Spraying of Plants' as a textbook, while Mr. R. H. Pettit of the Entomological Department took the class for three days per week, giving them a series of lectures on 'Insects Injurious to Horticultural Crops.' As far as possible, students in this class were, for their required labor, given charge of the spraying operations in the gardens and grounds.

"A class of thirty-three juniors met three days per week during the spring term for lectures in landscape gardening. A few field days were given in order to afford a better idea of the landscape effects on the campus.

"Thirty-seven sophomores in the agricultural course and eighteen in the women's course were given instruction in plant propagation and

vegetable gardening, as a half-term study during the spring. The subject was presented by lectures in the class room, coincident with which training along the same line was given the young men in the afternoon.

"Two students in the class of 1900 wrote theses on work done in this department, and fourteen of the next graduating class have elected to do their thesis work along various lines in horticulture. These students should receive closer personal supervision than it will be possible for the present teaching force of the department to give them.

"In summing up, the writer has conducted four classes in full-term studies, and two in half term studies, besides the regular laboratory work each afternoon, and has had charge of the work for two theses—in all 189 students in the class work of the department. During the coming year there will be three additional classes.

"Special attention is called to the importance of the afternoon labor, in its connection with the teaching. The classes should be divided into sections small enough to permit of close personal attention by expert instructors."

The importance of providing a larger teaching force, as urged by Prof. Hedrick, should not be overlooked. During the past year it became necessary to have additional assistance and Mr. D. W. Trine, '92, took charge of the grafting and a part of the work in pruning for six weeks in the spring term. Next year the classes will be larger and the elective senior work will add fully fifty per cent to what has been done the past year.

In addition to the laboratory work outlined above, the students have, during the fall and spring terms, performed on two or three afternoons each week such work as was in season. In the autumn, the work was for the most part done at the greenhouse, and consisted of making cuttings, potting and repotting plants and other routine greenhouse work, although others were engaged in the orchards and vegetable gardens, or on the grounds.

In the spring term, five afternoons were spent in practice work in grafting and about the same time in pruning the different kinds of fruit trees, bushes and ornamental shrubs. Each student was also given practical training in planting trees and other fruit plants, as well as in the making of borders and flower beds.

SPECIAL COURSES.

During the winter, special six weeks' courses were given in fruit culture and in commercial floriculture and winter vegetable gardening.

The work was conducted along similar lines to that given the regular students. In addition to the practical work and the lectures in the above topics, lectures and laboratory work in botany and entomology were given, Prof. Wheeler having charge of the former, while Mr. Pettit took the class in entomology. Prof. U. P. Hedrick also gave a number of lectures upon the chemistry of the soil, plants and fertilizers.

THE GROUNDS.

As in previous years, a large part of the work of the department, aside from the time spent with the students, has been devoted to caring for and improving the grounds, and, as has been customary, the endeavor has been to take some portion of the grounds and make such

improvements there as time and the conditions warrant. Last summer the work upon the "Water Garden," begun in 1898, was completed, and in the fall the north portion of the grounds received attention. Some years ago considerable time was given to improving the "Gravel Road," so called, along the north side of the campus, in order to lessen the driving through the grounds, which was so common, by farmers going to and from Lansing, when the College drives were better than the highway. As the road was becoming considerably worn, it was again graded and graveled, from the east side of the apple orchard to the "White Elephant" at the Trowbridge corner, the distance being one mile. The worst portion of the road was north of the Arboretum, near where the north drive enters the grounds. At this point the roadbed was lower than the surrounding land and it was noted for mud in wet seasons and for its dust when the weather was dry.

To remedy this, a tile drain was laid in the gutters on either side and connections made that would carry off the water. A grade was then established from twelve to eighteen inches above the original grade, and by means of a wheel scraper it was rapidly brought up to this level with soil taken from the roadway on either side of the hollow.

As this offered an excellent opportunity for testing different methods of improving roads under adverse conditions, it was determined to test various road materials. About 800 feet of roadway were selected for the experiment, and of this 320 feet was located in the hollow where the mud had been deepest and where the fill had been greatest. This was divided into four sections of eighty feet each, and the following materials were selected: 1. Clay covered with gravel, the under soil being a sandy loam; 2. cobble stones, taken from a neighboring field, covered with clay and gravel; 3. field stone, covered with four inches of broken stone; 4. broken stone.

The roadway as laid out was twenty feet wide from shoulder to shoulder, and in the center a space twelve feet wide was prepared for the materials mentioned above. Clay and gravel were placed along the sides so as to form shoulders six inches high, after giving the roadbed a crown of three inches and covering it with two inches of gravel. This, as well as the shoulders, was thoroughly rolled, and the road materials were then put in place. The clay and broken stone were spread in two-inch layers, each of which was well rolled.

In placing the cobble stones, the larger ones, many of which were flat, were placed at the bottom, and smaller ones were fitted between them. In section No. 2, a second layer of small stones was spread over this, making about eight inches of stone; while in section No. 3 about four inches of broken stone formed the top layer. The broken stone used here and in section No. 4 was a limestone, and rather soft for the purpose, but it was the best that could be readily procured. Section No. 4 was constructed of six inches of broken stone upon a firm, sandy loam bottom. Other sections were then added, the materials being clay upon sand, sand upon clay, and hard coal ashes and soft coal cinders upon both sand and clay.

Although the work was done during November and December, the sections came through the winter with little injury, although subjected to a very heavy traffic. The sections upon which clay was used became rather soft in muddy weather and the clay was carried upon the wheels

of the wagons and distributed upon the stone sections so that they had an inch or so of soft mud upon them during muddy times. Sections 2 and 4 showed little or no effect of the heavy teaming, but on section 3 the heavy teams had formed ruts about two inches deep for a few feet at the east end, owing to the settling of the stone into the wet soil beneath, but at no place had the wheels broken through, and a light top-dressing of broken stone put it into good condition again.

The condition of the different sections will be noted and reports made from time to time.

THE CAMPUS.

The bringing of the street cars upon the grounds opened up a portion of the campus that had previously been little used, and last spring arrangements were made to decorate it with trees and shrubbery. Borders were prepared upon both sides of the car track, as well as bordering the carriage drive and foot path, from the street car station to the entrance at the northeast corner of the Arboretum, and also along the north side of the deer park.

About one thousand shrubs, one hundred shade trees and seventy-five evergreens, besides a large number of herbaceous perennials and annuals were used. Nearly all were grown in the College nursery and greenhouse by the students, and the greater part of the work of planting and caring for the borders was done by them.

The water garden started last year was a mass of flowers throughout the summer and the shrubbery and herbaceous perennials planted on the borders made a very satisfactory growth, showing little effect of the dry weather, although most of the other shrubbery, as well as the lawns and flower beds, suffered severely.

If the drives and lawns are to be kept in a satisfactory condition, some provision should be made for sprinkling them. This will require the expenditure of about $250 for a street sprinkler and an equal amount for hose, sprinklers, hydrants and water pipe. The expense of sprinkling the drives would probably vary from $150 to $300, according to the distribution of the rainfall, and the cost of watering the lawns would be about the same.

The two elk, three deer and three Angora goats belonging to the department are in a satisfactory condition and are quite an attraction with visitors. The addition of buffalo, antelope and other forms is suggested.

ORCHARDS AND GARDENS.

The severe wind and rain storm on June 7 broke many branches from the shade trees, but only three or four were so injured that removal was necessary. In the orchards the damage was much more serious, and many of the large apple and cherry trees were broken down, while about fifty of the smaller ones were torn out by the roots.

The large pear trees and the old apple orchard gave good crops last year, and promise well the present season.

The trees were all thoroughly pruned in the spring and the trunks were scrubbed with a paste made of four parts of ashes, one of lime, and sufficient dry earth to relieve the color of the lime. This has given

the bark on the trunks and larger branches a smooth and glossy appearance.

The orchards are plowed in the spring and cultivated with spring-tooth harrow or weeder, every week until August, when some cover crop is sown, oats or crimson clover being generally employed.

Careful attention was also given to the spraying of the trees, and in addition to an application of copper sulphate before the buds opened, Bordeaux mixture and a white arsenic have been used every three weeks since the blossoms dropped, and another application will be made to the winter apples about the middle of July.

The vegetable garden has given good returns, as, besides affording practice work to the students in growing and marketing the various crops, it furnished a supply of vegetables for most of the boarding clubs and members of the faculty. Practically all were sold upon the grounds, except some of the early cabbages, tomatoes and lettuce from the greenhouse.

THE GREENHOUSES.

The greenhouses have remained under the charge of Mr. Thos. Gunson. Few changes have been made, except that the flow pipes to the heating coils, which were originally located beneath the benches to get them out of sight, have been placed overhead. This has resulted in a better circulation, and in the palm house, where the pipes are now located just below the plates, it has entirely prevented the breaking of the glass in the lower row, by the forming of ice at the eaves, which has been quite troublesome in former years.

The plants in the main house have become so large that it has been found necessary to cut them back. In order that the College may grow palms and other tall plants in a satisfactory manner, a large palm house is needed. Otherwise the houses serve their purpose well, and besides furnishing opportunities for practice work to the students, they supply bedding plants for the grounds, plants and flowers for decorative purposes for society and other functions, and means of illustration for the classes in horticulture and botany.

SOCIETIES AND FAIRS.

During the year I have attended two meetings of the State Horticultural Society and two of the American Park and Out Door Art Association at Detroit and Chicago. I also was present at the 1899 session of the Society of American Florists, and of the American Pomological Society at Philadelphia. For the latter society I have had charge, as general chairman, of the preparation of the Report of the General Fruit Committee. I have also visited the leading fruit growing centers of the State, and addressed a number of local horticultural societies. At the State Fair and at the Eaton County Fair at Charlotte, I acted as judge in the departments of fruits and vegetables. At the "Round-up" Institute at Ann Arbor I spoke on "The Spraying of Orchards," and reported the proceedings for the M. A. C. Record, of whose editorial board I have acted as a member since January.

ROUTINE WORK.

Until today, Mr. C. A. Wood has been in charge of the work in the gardens and grounds. He has been very faithful in the performance

of his duties and has handled the teams and men in a very satisfactory manner. Owing to the small force available for supervising the afternoon work of the students, it has been necessary to utilize him for this purpose during much of the year, and as the position of foreman has now been abolished, it will make the task of conducting the student labor all the more difficult.

In addition to performing the regular work upon the gardens, grounds and orchards, the teams were employed for several weeks during the fall in making a road to the railroad station at Trowbridge, the former road having been utilized for the College spur track, and in making the drives upon Oakwood addition.

A large amount of work, also, was done in excavating for the new Women's Building, and in hauling brick, lumber, lime and broken stone for the contractor. The hauling of wood, coal and furniture, and drayage for the different departments, has taken no little time, while the filling of the ice house and the making of paths in the winter, and the delivering of ice in the summer, also fall to this department.

L. R. TAFT,
Professor of Horticulture and Landscape Gardening and Superintendent of Horticultural Department.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1900.

DEPARTMENT OF CHEMISTRY.

President J. L. Snyder:

SIR—We herewith submit the report of the Chemical Department for the College year closing June 30, 1900:

The year has been full of work, both in the class room and in the laboratory; the classes have been large, and the interest of the students has been unflagging; the perplexing condition has been to find table room in the laboratory for all who wanted to take work in chemical manipulation and making chemical investigations. The classes are now so large that many of them must be divided into sections in order to find space for work in the laboratory. With the large prospective increase in numbers of students in the higher classes, the question of room for the workers in chemistry becomes one of anxiety. When this laboratory was built in 1871 it was supposed to be ample for any future increase. But the normal cry of growth and expansion is now heard—"the place is too strait for me; give place to me that I may dwell." The laboratory space that was for a time surrendered to the Physical Department will soon be required for the use of our growing classes.

INSTRUCTION IN CLASSES.

During the year instruction has been given in elementary chemistry to the students in the sophomore class in the agricultural course and to the students of the same class in the women's course, for one term. The instruction in both classes included five lectures a week and two hours of laboratory work.

The same students in these two courses devoted one term (two hours a day) to analytical chemistry, and the following term to organic chemistry, with laboratory practice.

In the mechanical course, the students spent six hours a week in mineralogy, or the special study of the metals as related to mechanics.

During the winter term a course of lectures was given to the junior agriculturals on agricultural chemistry.

In the spring term a course of lectures on meteorology was given to the senior agriculturals who elected that study.

The following scheme of number of students, hours of class work and studies, will give at a glance the work of the department:

Fall term.	Students.	Hours per week.
General Chemistry	93	7
Organic "	40	8
	133	15
Winter term.	**Students.**	**Hours per week.**
General Chemistry	69	7
Agricultural "	36	5
Analytical "	65	10
	180	22
Spring term.	**Students.**	**Hours per week.**
Mineralogy	44	6
Meteorology	10	5
	54	11
Sugar beets	10 (8 weeks)	36

In addition to the regular class studies, some students devoted special attention to other lines of chemical study and work, e. g., assaying of precious metals, analysis of coals, fertilizers, etc.

SUGAR BEETS.

The College for years has taken a lively interest in the sugar beet industry. In the winter and spring of 1899 the Chemical Department organized a class in beet-sugar technology, giving instruction in the analysis of sugar beets and determining its leading constituents, and affording the practical working of apparatus for rapid determination of the questions involved in the manufacturing of beet sugar. Such good results were reached in this course that four of the class (A. N. Clark, H. S. Reed, W. S. Watling and F. E. West) found ready employment in as many factories in this State.

At a corresponding date this year a class of ten presented themselves for instruction in the sugar beet course, spending six hours a day in analysis of the sugar beet with the most approved machinery and ap-

paratus of latest pattern and used in the best factories. Many came from a distance; all worked with enthusiasm, and expressed themselves as greatly pleased and benefited by their course in the beet sugar class.

In this instruction of the class in sugar beets valuable assistance was afforded by Mr. A. N. Clark, and we take pleasure in acknowledging his timely aid.

It is a gratification to know that not only can the College promote a great industry in our State, but can furnish a portion of the scientific equipment to carry it on.

The department has also received valuable help from Miss T. A. Bristol, B. S., and from the following students: C. H. Hilton, H. S. Reed and L. G. Michael.

THE VALUATION OF CATTLE FOODS.

The large consumption of by-products of mills and factories to reinforce the fodders of the farm in stock feeding, makes it desirable to determine the real value of these commercial products. In some states this is systematically done, the composition is branded upon every package offered for sale, and the stockman has some assurance of the value of the material he buys.

It is a maxim in finance that the cheaper metal passing as currency will supplant the dearer metal. This law is not confined to coined metals. Wherever a cheap material may be successfully substituted for a more valuable one, the cheap material will drive out the more costly, unless the cheat is exposed in some convincing way. It was so in the fertilizer trade in Michigan prior to 1885. Fertilizers of little or no value, under a variety of catch names, were poured in upon us from surrounding states. When the fertilizer law of 1885 was enacted and enforced, the spurious materials soon disappeared from our markets and good fertilizers took their place.

A similar condition has arisen in regard to cattle foods, which have become commercial articles. Formerly they consisted mainly of wheat bran, "ground feed" (corn and oats), and oil meal. A large number of other products are now upon the market, of widely varying value. Many have been sent to this laboratory for analysis. Two classes of these "feed stuffs" are here quoted to show their comparative feeding value, as determined by analysis, without any corresponding variation in the price. The value is measured by the quantity of crude protein (nitrogenous food material) they contain.

President T. F. Marston sent two kinds of buckwheat bran for analysis, which had the following amount of the most valuable food material:

Coarse buckwheat bran had 24.80 per cent of crude protein.

Fine buckwhat bran had 34.06 per cent of crude protein.

Both kinds bore the same price, while the fine bran had nearly one-third more value.

Specimens of ground oat hulls, found in the open market, and closely resembling each other in appearance, gave the following results:

Ground oat hulls from Iowa had 6.61 per cent crude protein.

Ground oat hulls from Detroit had 15.58 per cent crude protein.

Both sold at the same price, though one had more than twice the feeding value of the other.

These are only a few samples out of many found in the market, and suggest the need of a law for the analysis, license and branding of com-

mercial cattle foods, for the protection of stock feeders as well as honest dealers, the same as in commercial fertilizers. It is not proposed to set up a standard for any feeding stuff, but to let each manufacturer make his own standard, and then require him to keep his commercial goods up to that standard.

THESIS WORK.

Students who elect chemical lines of work for graduating thesis require assistance and direction for courses in chemical laboratory, to enable them to make original investigations. Work of value is thus secured. Thus C. H. Hilton made a determination of the amount and state of combination of sulphur in the mineral coals of our State; C. H. Parker the sugar content and mineral matter in the crowns and bodies of sugar beets, with determination of marc by several methods; F. E. West, the solids, ash elements (and quantitative analysis) and sugar in leaves, crown and body of sugar beets; Miss Irma Thompson, the nature, composition and action of the commercial "preservalines" found in the market and offered to the trade.

These subjects are of public interest and have utility commanding attention, something of value beyond that of a well-written essay.

OUTSIDE WORK.

By direction of the Board of Agriculture, I went to San Francisco, Cal., to represent the College in the joint meeting of the Agricultural Colleges and Experiment Stations on July 5 to 7, 1899. The meeting was one of great interest and profit, and it was a gratification to hear "the Michigan College" so often referred to as a model of its class.

By invitation of the United States Industrial Commission I appeared before that body in Washington, D. C., on May 14, 1900, to give evidence in regard to the beet sugar industry in Michigan, as one of the industries of national importance in the estimation of the Commission. Once more I found Michigan quoted as the typical State for this great industry.

Respectfully submitted,

R. C. KEDZIE,
Professor of Chemistry.

F. S. KEDZIE,
Adjunct Professor of Chemistry.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1900.

REPORT OF THE MECHANICAL DEPARTMENT.

To the President:

SIR—I have the honor of submitting the following report of the work done in the Mechanical Department during the year ending June 30, 1900:

The work in the class rooms, drawing rooms, etc., has been conducted as follows:

FALL TERM.

Seniors.—Thermodynamics, Graphical Statics of Mechanism and Elementary Kinematics by Prof. Weil. Experimental Laboratory and Steam Engine Design by Mr. Smith. Shop Practice by Mr. Leonard.

Juniors.—Machine Design by Mr. Smith. Metallurgy by Prof. Weil. Shop Practice by Mr. Leonard and Mr. Theadore.

Sophomores.—Shop Methods by Mr. Leonard. Shop Practice by Messrs. Leonard, Theadore and Baker.

Freshmen.—Shop practice by Mr. Bradford and Mr. Baker.

WINTER TERM.

Seniors.—Advanced Kinematics by Prof. Weil. Steam Engineering Laboratory by Mr. Smith. Advanced Machine Design by Mr. Leonard.

Juniors.—Machine Design, Steam Engine Design, and Valve Gears by Prof. Moseley. Boilers by Prof. Weil. Shop Practice by Mr. Leonard.

Sophomores.—Elements of Machine Design by Mr. Smith. Shop Practice by Messrs. Leonard, Theadore and Baker.

Freshmen.—Shop Practice by Mr. Bradford and Mr. Baker.

SPRING TERM.

Seniors.—Engineering Practice and Thesis Work by Prof. Weil. Original Design by Prof. Moseley.

Juniors.—Strength of Materials and Testing Materials of Engineering by Prof. Moseley. Shop Practice by Mr. Leonard.

Sophomores.—Elements of Machine Design and Elements of Steam Engine by Mr. Smith. Shop Practice by Messrs. Leonard, Theadore and Baker.

Freshmen.—Shop Practice by Messrs. Bradford, Baker and Newman.

At the beginning of the College year Mr. A. L. Westcott resigned his position as senior instructor in this department to accept the position of professor of mechanical engineering at the University of Montana. Mr. Westcott's promotion is indicative of his ability and the character of his work.

After Prof. Westcott withdrew from the department no addition was made to our teaching force until January 1, 1900, when Mr. A. W. Moseley was elected assistant professor of mechanical engineering. Mr. Moseley is a man of experience in engineering, both in practice and teaching,—the latter experience having been gained as assistant and instructor at the Massachusetts Institute of Technology.

Notwithstanding the very large attendance in this department during the past year, and the necessity experienced of carrying on the work, for a considerable period, with less than the usual number of instructors, it was still found possible to complete a fair amount of apparatus in our shops during the year; a list and descriptions of the apparatus may be found in our inventory. Among the more important apparatus finished this year may be mentioned a ten-inch wood lathe and a fifteen-inch shaper.

As usual, considerable work has been done in the shops during the year in the way of repairs.

Our request a year ago for more machine tools has been responded to in a manner that is very gratifying to this department, and, at the present time, arrangements are being made for the addition of three lathes and a planer to our machine shop equipment.

The number of students taking work in this department has greatly increased of late years and our laboratory is crowded. It is necessary —in the opinion of the writer—that some provision be made for securing more floor space for the use of this department; an additional building at this College could be profitably utilized for engineering and drawing-room work.

During the past twelve months the writer has carried on considerable work for the College as consulting engineer in connection with heating plans, etc.

We would record here that this year we entered the first class in the "Five-Year Mechanical Course."

Respectfully submitted,

CHAS. L. WEIL,

Professor of Mechanical Engineering.

Agricultural College, Mich.,
June 30, 1900.

REPORT OF THE DEPARTMENT OF BOTANY AND FORESTRY.

To the President:

I have the honor to submit my report for the year closing June 30, 1900:

During the year students have received instruction in this department as shown in the following table:

Class.	Subject.	Term.	Hours per week.	No. of students enrolled.
Senior	Thesis	Fall and spring		1
Junior	Parasitic fungi	Fall	9	35
"	Weeds	Winter, 4 weeks	5	14
"	Grasses	Winter, 4 weeks	5	18
"	Forestry	Winter, 6 weeks	5	31
"	Systematic botany	Spring	8	39
"	Trees and shrubs	Spring	3	5
Sophomores (Agricultural)	Plant histology	Winter	9	33
Sophomores (Women)	Plant histology	Spring	7	17
Sophomores (Women)	Trees and shrubs	Spring	3	19
Freshmen (Men and women)	Structural botany	Fall	7½	140
Freshmen (Men and women)	Structural botany	Winter, 20 lessons	2	98
Special students	Sugar beets	Spring, 8 weeks	3	7
Special students	Botany	Winter, 6 weeks	10	7
Total				464

Fortunately there has been no change in the teaching force during the year. Besides the professor of botany and forestry, an assistant professor devotes half of his time for half of his salary to teaching, and an instructor all of his time. In other words, the teaching force consists of two and one-half men. Much of this instruction consists in laboratory work, hence it is more costly than ordinary class-room teaching. For example, last fall thirty-five juniors were instructed in the study of parasitic fungi, devoting nine hours per week to the subject, requiring the attendance of two teachers. Had the subject been history or something of the kind, one person alone would properly have taught the class in five hours. When we take into account the extra time required of one or both teachers in botany to prepare specimens for the class, out of class hours, it will be found that to teach these juniors botany costs four to five times as much as it would cost to teach them history. But this extra cost gives a valuable training to be obtained in no other way.

During the spring term of the past year there was less class-room work in botany than last year, or less than there will be next year. This is accounted for by the fact that the subject of trees and shrubs in the course has been shifted from the sophomore year to the junior year.

Let no person venture to gauge the amount of work performed in the department, by looking over the schedule of classes as written above!

It does not include a bit over half of the work that falls to the department to perform.

During most of the year I have spent much time in the preparation of a general catalogue of the students of the College, and in looking after a clerk who was employed in the work.

I have answered a very large number of letters of inquiry concerning a great variety of subjects, a considerable portion coming to me owing to my long connection with the College. None of this, excepting on the general catalogue, has been done by a clerk, as the money allowance has not been sufficient to employ one. I have not called on the assistant professor nor the instructor to do any of this work, because they had all the work they were able to perform without it. As you know, requests come in every week for a contribution to the "Michigan Farmer" and the "M. A. C. Record." All old students who visit the College call to pay their respects, as I am one of two or three who were here when they were students. This is a very pleasant duty, nevertheless it consumes much time. Then there are meetings of committees, reports, papers to be prepared for several scientific societies and journals, work in connection with the increase and care of the herbarium.

The work in the botanic garden is performed by a person who has no knowledge of botany. All of the 2,000 plants are looked after by myself, assisted in some points by Professor Wheeler. The labeling, arrangement, planting the seeds, the transplanting into the proper places, the oversight in detail devolves on myself. Numbers of exchanges of plants and seeds have been made with other gardens and other colleges.

THE HERBARIUM.

I regret to inform you that the additions to the herbarium during the past year have been much less than for any of the ten previous years, not mentioning those for 1898-99. This is owing to the fact that the allowance of money for the department has been much reduced.

The additions for the year have been as follows:

SEED-PLANTS, FERNS AND THEIR ALLIES.

T. J. Fitzpatrick, plants from Iowa	416
W. C. Cusick, plants from Eastern Oregon	344
C. D. McLouth, plants from Muskegon county, Mich	463
C. G. Pringle, plants from Mexico	260
W. W. Eggleston, plants from Vermont	112
H. C. Skeels, plants from Kent county, Mich	210
W. J. Beal, native trees and shrubs of Michigan	200
U. P. Hedrick, plants from Utah	145
The U. S. National Museum	52
W. A. Kellerman, plants from Ohio	6
B. Barlow, plants from Puerto Rico, W. I	4
	2,212

HEPATICÆ.

Underwood and Cook, plants of N. A	20

FUNGI.

Seymour and Earle	50
Briosi and Cavara, plants from Europe, Fascicles XIII, XIV	50
	100

ALGÆ.

Collins, Holden and Setchell, Fascicle a	25
Collins, Holden and Setchell, Fascicle 13	50
Collins, Holden and Setchell, Fascicle 14	50
J. E. Tilden	100
	225
Total additions for the year closing June 30, 1900	2,557

GENERAL SUMMARY OF PLANTS IN THE HERBARIUM.

Seed-plants (Spermatophyta)	56,526
Ferns and their allies (Pteridophyta)	1,142
Mosses and Liverworts	1,887
Lichens	1,135
Fungi	9,544
Algæ	1,270
Total number in the herbarium	71,504

THE BOTANIC GARDEN.

For over twenty-five years, I have had an interesting garden in which large numbers of grasses, clovers and the like were grown. It was the oldest one of the kind in this country. From it I have been able to send specimens to six or seven other agricultural colleges. Owing to a lack of means to keep it in proper condition, this portion of the botanic garden—nearly an acre in extent—I was forced to abandon, and it was done with great reluctance, I assure you. The fact that a railroad went through the garden at a later period should not conceal the first cause for abandoning the project. The "curiosity strip" of the Experiment Station, as kept up for some years past, has never come anywhere near taking its place.

As elsewhere mentioned, the area of the garden has been reduced from three acres to two acres, for want of means to keep it in good order. What remains, I hope to maintain in a better condition than ever before. I am reducing the area occupied by some of the families and enlarging others, though their relative positions remain unchanged. I continue to add plants of more use in agriculture and horticulture and to discard the cultivation of some of the others.

THE ARBORETUM AND THE WOODS OF THE COLLEGE.

These have made few changes during the past year. At the urgent solicitation of the professor of horticulture, a small portion of the arboretum was set off in the deer park. As I expected, and said when

this concession was made, every tree and shrub, with the trunk two inches or less in diameter, has been destroyed by the deer and elk, with the exception of a portion of the shagbark hickories, and in many instances larger trees have been destroyed or are on the way to destruction.

Some of the beeches and other trees that were on the decline have been removed; nothing more has been planted during the year.

DONATIONS.

From J. T. Wight, San Diego, Cal.: One photograph of a tree growing from a split rock.

From A. D. Hopkins, Morgantown, West Va.: Twelve varieties of living plants of timothy, also seeds of the same.

From L. C. Corbett, Morgantown, West Va.: One garden label.

From C. P. Close, Logan, Utah: One lot of scabby plums.

From J. F. Miller, Wayne, Mich.: Six plants of albinos of the common black huckleberry.

From W. A. Kellerman, Columbus, Ohio: Live plants of Vernonia.

From Albert Strong, Ashtemo, Mich.: One double spike of wheat.

From W. F. Ganong, Northampton, Mass.: Ten packages of seeds.

From F. Thistleton-Dyer, Kew, England: Twenty-two packages of seeds.

From A. B. Cordley, Corvallis, Oregon: Specimens of Glœosporium malicorticis.

From N. L. Britton, Botanic Garden, N. Y.: Five hundred and fifty packages of seeds.

GIFTS TO OTHERS.

To the Arnold Arboretum, Boston, Mass.: Cuttings of 22 kinds of willows, 180 species of herbarium specimens of woody plants.

To the University of Michigan: Living plants of Bocconia.

To the U. S. Department of Agriculture: One hundred and eighty species of herbarium specimens of woody plants.

To the Botanic Garden of New York City: One hundred and eighty species of herbarium specimens of woody plants, one living plant.

To the Agricultural College, Nevada: Thirteen samples of timber, 117 kinds of seeds of weeds.

To the City of Detroit for their parks: Cuttings of 22 kinds of willows.

With very best wishes, I am, sincerely yours,

W. J. BEAL,

Professor of Botany and Forestry.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1900.

REPORT OF THE DEPARTMENT OF ZOOLOGY AND PHYSIOLOGY.

To the President:

SIR—I have the honor to submit the following report of the Department of Zoology and Physiology for the year ending June 30, 1900:

There has been no change in the personnel of the department during the year, and considering the fact that a new subject and class was added to the schedule, and that the total number of students taught was somewhat larger than last year, the work has been done as satisfactorily as was possible.

The schedule of classes was as follows:

Fall term—Economic Zoology, senior elective for agriculturals, 5 students. Anatomy and Physiology, required study for agricultural sophomores, 57 students. Anatomy and Physiology for women sophomores, 22 students.

Winter term—Geology, elective for agricultural seniors, 10 students. Anatomy and Physiology for agricultural sophomores, 42 students. Anatomy and Physiology for women sophomores, 20 students. Physical Geography for five-year mechanical freshmen, 27 students. Entomology for special short course (fruit growing), 6 students.

Spring term—Entomology for agricultural sophomores, 36 students. Entomology, elective for seniors, not enough applicants to warrant forming a class.

In this department all students received laboratory instruction, the larger classes being divided into four or five sections. Both in anatomy and entomology the sections were so large that the laboratory would not accommodate all at once and it was necessary to place tables in the lecture room and handle one section there.

The class in Physical Geography was a new one, that subject having been added to the five-year mechanical course. The subject, however, is one which, in my opinion, should be taught in the agricultural course as well, and the geology, which is now a senior elective, should be required of all students, in all courses, but considerably earlier in the course than the senior year.

A glance at the above schedule will show that the work of the year is very unevenly distributed, and it is evident that the winter term is too crowded for the best results, with the present staff; another assistant would greatly improve the work in that term. This is the more desirable, since it is now impossible for us to do anything for the Farmers' Institutes after the opening of the winter term. During December, 1899, the head of the department attended the Farmers' Institutes in Ogemaw, Crawford and Otsego counties, and Mr. Pettit spent two weeks in institute work in other counties.

The equipment of the department is improving every year; we now have nearly all the microscopes we need, and the electric projection lantern has been very useful in most of the classes. More than one hun-

dred lantern slides have been made during the year, and a much larger number of permanent microscopic mounts.

The bird boxes, placed about the campus in the spring of 1899 for the purpose of encouraging bluebirds, wrens, martins, swallows and other valuable native birds, have been maintained and watched so far as practicable during the present season, and their continuance is fully warranted.

Thus far no swallows or martins have used the boxes, but the number of wrens on the campus has been more than trebled, at least eight of the boxes being used by that species the present season. The bluebird still holds aloof and it is not probable that its former numbers will ever be restored in this vicinity unless the English sparrows, which increase yearly, are almost exterminated.

WALTER B. BARROWS,
Professor of Zoology and Physiology.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1900.

REPORT OF THE DEPARTMENT OF ENGLISH AND MODERN LANGUAGES.

President J. L. Snyder:

SIR—The following is a summary of the work of the Department of English and Modern Languages during the year just closed:

During the fall term the number of classes and sections of classes in the department was twenty, and the average enrollment in each class or section was thirty-two. An average of three hundred and forty-three essays each week was handled, each essay being carefully and minutely criticised and corrected before being returned to the student. In the winter term the number of classes and divisions remained the same, but the average membership in the classes fell to twenty-eight. The number of essays per week handled was three hundred and one (average). In the spring term the number of classes and division was eighteen, with an average membership of twenty-four, and the weekly number of essays was two hundred and forty-one.

Besides this the oration work each term has taken up much time and thought. During the fall term I personally had this work in hand, but during the spring terms I turned it over to Mr. King, who is especially prepared for such work. He has been giving the juniors and seniors careful attention in this respect, and we hope to make this feature of the work count for much more than ever before in the training given by the courses.

Much of my own time has been taken up in the general work of the College, such as adapting a new system of records to the work of the College, preparing daily programs for the classes in each term, editing the college catalogue, and the like—work which makes no showing, and which anybody with sufficient patience and sufficient knowledge of the intricate interests involved can do, but which becomes more serious in amount and more insistent and time-absorbing in character as the attendance at the College and the variety of the work done increases. I feel it to be unfair to myself in summing up the work of the year not to mention and lay stress upon this fact.

On January 1st last, Mr. D. J. Crosby severed his connection with this department. I desire here to record my high appreciation of his very earnest and efficient work. He showed himself at all times willing, active, well-equipped and successful, and I regretted to part with him. To succeed him we have Mr. E. S. King, of Northwestern University. Mr. King has demonstrated his thorough preparation for his work and will prove an acquisition to the department.

On account of the pressure of work in our department in the fall term, Prof. W. O. Hedrick kindly consented to take a class in our work, in return for which I had his class in psychology in the spring term, when his work is very heavy. I hope the arrangement was as satisfactory to him as it was to us.

For several years, when the congested condition of our work has rendered it necessary, Mrs. Linda E. Landon, our librarian, has taken classes in this department. The addition of the new teacher granted by the Board to this department for the coming year, and the increase of work and responsibility in the library, will render such an arrangement for the future unnecessary and impossible. I therefore take this opportunity to express my thanks for her unselfish and efficient help at times when it was sorely needed. Our constant effort in this work is to adapt it more and more closely to the needs of our students, and in this effort changes are made year by year as the necessity for such changes becomes apparent. For the coming year we have planned to rearrange our literature work so as to make it more closely and economically consecutive. The essay work, too, which we regard as the central feature of our work, will be more carefully planned and worked over during the vacation. The German and the French of the department will be differentiated for the two courses in which these languages occur, and an effort made to adapt the texts used in each course to the requirements of the particular course.

Very respectfully submitted,

HOWARD EDWARDS,

Professor.

Agricultural College, Mich.,

June 30, 1900.

REPORT OF VETERINARY AND MILITARY DEPARTMENTS.

To the President:

SIR—I have the honor of making the following report for the Veterinary and Military Departments for the year ending June 30, 1900:

The work of the Veterinary Department during the past year has been carried on similar to that in previous years. It has been our aim to make the work as practical as possible, and with this in view we inaugurated at the beginning of the year a free clinic, with the hopes that the surrounding community might thus furnish some practical illustrations of what was being taught in the class-room. While this phase of the work has not been all that might be wished, yet perhaps it has been as good as could be expected for the first year, inasmuch as the students have in this way been able to see a number of different cases. It is hoped that opportunities along this line may increase.

In the class-room those seniors electing the subject have received throughout the year instruction with reference to the anatomy of the domesticated animals, the diseases affecting them, causes, symptoms and treatment of these diseases, special attention being paid to the prevention and hygienic treatment. The medicines used received discussion as to their source, actions, uses and dose. In all our work we bear in mind that the students are to become stockmen and farmers rather than professional veterinarians. During the last three weeks of the fall term, two hours a day were spent in the dissecting room, where an old horse destroyed for the purpose was dissected, as was also parts of the other animals where there is a marked difference.

During the first half of the winter term the sophomore class received thirty lectures; these included a discussion of the most common digestive disorders, the most common lamenesses, along with some of the disorders of the other systems, also the accidents and diseases incident to parturition and the diseases of the dairy cow.

The special short course students received, also during the first half of the winter term, thirty lectures covering about the same ground as that covered by those given to the sophomores; except, owing to the fact that these students, as a rule, had received less preparatory work, the lectures had to be modified to some extent.

For the past two years the Military Department has been under my charge. In this department I have endeavored to carry on the work in a manner similar to the way it was carried on by the officers in previous years. The cadets have been organized into a battalion of four companies, staff and band. The freshmen have met for drill three days each week during the year; the upper classmen have met the same, except during the last half of the fall and the first half of the winter term, when they are not required to take the work. Cadet officers have had charge of the companies and in most cases they, and also the privates, have shown a good degree of interest in the work. The drill has included the school of the soldier, the school of the company including platoon drill, the formation of the battalion and the battalion cere-

monies, parade, review and inspection. In all the work we have taken "Infantry Drill Regulations," as last revised, as our guide.

During the last ten weeks of the fall term the sophomores met twice a week for theoretical work. "Infantry Drill Regulations" was used as a text-book, the ground covered being the same as in the practical work on the parade ground, and also the general organization of the army. The department was inspected June 7 by Capt. S. W. Dunning, 16th Infantry, U. S. Army.

Respectfully submitted.

GEO. A. WATERMAN,
Professor of Veterinary Science.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1900.

REPORT OF THE WOMEN'S DEPARTMENT.

To the President:

SIR—The dean of the Women's Department has the honor to submit the following report for the twelve months ending June 15, 1900:

The College year 1898-99 closed with rejoicing over the appropriation of money for a new dormitory. With this building the College gains space for the accommodation of the increasing numbers of women desiring to enter the women's course. The walls and roof of this building are now almost complete and we expect to occupy it in the fall. Plain and substantial, it stands one of the most dignified buildings on the campus.

The officers of the Women's Department for the past year have been four, a dean, a teacher of sewing, a teacher of domestic science and a teacher of music. After the appointment of Professor Bemies as director of physical culture the services of Miss Ronan in gymnastics were not retained. For the year past, young women in gymnastics have been in charge of Professor Bemies.

Other regular work of the department started at the opening of the fall term with one substitution and several additions. The wood-work with freshmen women was omitted because we lacked space for a workshop. In place of this, a one-hour course was given by the dean of the department. This course was called ethics and aimed at a training in moral responsibility.

In sewing, one term was added to the course for juniors.

The course in domestic science is expanding. During the year past, one hour of lecture was added to the regular four hours of freshman cookery. The one-hour lecture course in domestic science has been doubled. The new senior elective in advanced cookery was begun, and lasted through the fall term. A new course, invalid cookery, four hours

a week, was offered in the spring term to juniors. In all, eleven hours have been added to the course in domestic science.

In the middle of the fall term Miss Rushmore resigned to accept a more responsible position. The College has been fortunate in securing Miss Belle C. Crowe of Truro, Nova Scotia, to carry on the work so well begun by Miss Rushmore.

The triennial banquet, largely under the direction of Miss Crowe, was the occasion of a triumph for both teacher and students in domestic science.

The music has been carried on as usual by Mrs. Marshall. A cantata by the chorus, and the music at chapel and commencement, attest the efficiency of pupils and the quality of their training.

The value of the equipment and furnishings of Abbot Hall is about $2,000. These furnishings we shall take with us to the new building. During the year we have added three carbon photographs and two large casts, as wall decorations of our parlors. The value of these articles is about $75.

During the two years of my office we have tested regulations which will be printed for use in the new dormitory. My own work has varied. During the fall term there were ten hours of teaching, in which I met four different classes. During the other two terms my teaching was one hour a week. We have had no housekeeper during the year, and this gave the care of the house to me. I have had, also, care of the sick. Fewer students have been sick this year than the year before, owing perhaps to better sanitary conditions of the house. The sickness has been cause of greater anxiety, however, because of its epidemic character, the diseases being tonsilitis, measles and scarlet fever.

I have had, as usual, the general executive work of the department in its relation to the College and in its relation to students.

I have to report, on the whole, a satisfactory year.

Respectfully,

MAUD RYLAND KELLER,

Dean of Women's Department.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1900.

DEPARTMENT OF DRAWING.

To the President:

DEAR SIR—I have the honor to present herewith the report of the work done in the Department of Drawing for the College year ending June 16, 1900:

Miss Holt, having been granted leave of absence for the year to continue her studies in Boston, Miss Elizabeth Sprague served very acceptably as her substitute.

Fall term—In order to give the freshmen engineers more time and better facilities for the selection of drawing instruments we tried the

plan of opening the course in drawing with five weeks of free-hand work. As this progressed, we endeavored by talks and advice to assist the men in selecting and purchasing instruments, but this seems to be a matter difficult to manage with complete satisfaction.

The class was divided into three sections, Miss Sprague taking charge of the one made up of the five-year men, while I, assisted by Mr. Newman, took charge of the two sections of four-year men. As a limbering up process, the free-hand drawing for five weeks was beneficial. The remainder of the term was devoted to instrumental drawing, Mr. Newman, Miss Sprague and myself each taking charge of a section.

During this term I instructed the sophomore engineers in descriptive geometry and the junior women in graphic arts, while Miss Sprague had the sophomore women in drawing from still life.

Winter term—The freshmen engineers' four-year course, in two sections, had machine sketching and drawing with Mr. Newman. The five-year engineers continued their instrumental drawing under my charge.

The freshman agriculturals and freshman women, in two sections, took free-hand drawing with Miss Sprague and myself. Heretofore the women have taken ten hours per week, but it has seemed advisable to distribute this work over two terms, thus giving five hours per week, an arrangement that appears to be beneficial on the whole.

The sophomore women continued their work under Miss Sprague.

Spring term—The freshman engineers, four-year course, took up descriptive geometry with me, assisted by Mr. Newman.

The freshman women continued their free-hand work with Miss Sprague, while the sophomores advanced in still life and cast drawing. The junior women and a few seniors formed a small but earnest class, which pursued the study of the history of art under my direction. The Department of Chemistry kindly allowed us the use of their stereopticon, which proved of great service in showing illustrations.

The need of the department, especially in mechanical drawing, for more class-rooms, better lighted and ventilated, is most urgent. The students work under a very serious disadvantage. The accommodations have been inadequate for the past three years, a condition that is an injustice to all concerned, especially the student who is likely to sustain permanent injury. Hoping that this matter may receive your consideration in the immediate future.

Faithfully,

W. S. HOLDSWORTH,

Assistant Professor in Charge.

Agricultural College, Mich.,

June 30, 1900.

REPORT OF THE DEPARTMENT OF ECONOMICS AND HISTORY.

To the President:

I have the honor of submitting the following report of the work done in this department during the year 1899-1900:

The apportionment of studies in the College schedule gave to my charge during the autumn term of this year United States history and general European history. A class of eleven seniors elected the former, while the latter was the required work for a class of twenty-five sophomore members of the women's course.

The newness of this latter course to our College curriculum renders some statement of details concerning it not out of place in this report. The course is planned to extend from the reign of Charlemagne to the present time in the study of European history. This plan of taking so much history at one time is rendered possible by the long length of this term—fourteen weeks of the school year. The attention of the class is given to only the most important lines of development of mankind throughout Europe during the period studied, and especial attention is directed to detecting growth from epoch to epoch and to the mastery of those facts which exemplify growth. The evolution of the world-mastering European society is thus studied and its present characteristics noted. Adams' European History is the text used in this course, Channings' Student History of the United States is used in the senior course.

By a coincidence of difficulty in handling the classes assigned the English Department and this department in the autumn and spring terms respectively, a grammar class fell to my charge during this term, Dr. Edwards reciprocating by teaching the class in psychology during the spring term.

In the winter term instruction was given by me to a class of fourteen seniors in political economy, to a class of forty-five juniors in civics, and to a class of nine junior women in early European history. This last course being given for the first time at this College this year, a few words of explanation possibly may be proper concerning it. Its especial purpose is the study of those difficult parts of middle age history out of which modern history comes. While the emphasis of the course is put upon these beginnings of modern history, a short study of Roman history is made to prepare the way to an understanding of the Teutonic migrations and the "dark ages" which follow, and the problems connected therewith. The course ends at the downfall of Charlemagne's empire. Allen's History of the Roman People and Emerton's Introduction to the Middle Ages are the texts used.

During the spring term one hundred and six students in the freshman class were instructed by me in English history. For class-room purposes this number was arranged in four sections, members of both women's and agricultural courses being classified together. It occurs to me, and I hope the change may be found practicable, that in view of

the widely different subsequent work in history done by members of these two courses, that desirable features of instruction might be obtained by keeping them separate in arranging the class-room sections.

Respectfully submitted,

WILBUR O. HEDRICK,

Assistant Professor of Economics and History.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1900.

REPORT OF THE DEPARTMENT OF PHYSICAL CULTURE.

To President Snyder:

SIR—The following is respectfully submitted as the report of the Department of Physical Culture for the year ending June 30, 1900:

The work of this department has been along the three-fold line of athletics and gymnastic work for young men, and calisthenics for young women. The ultimate object is to give systematic physical training to all the students, to correct defective positions of the body, and to stimulate general athletics in such a way as to actively engage a larger number of students.

This last was successfully carried out in track athletics this spring, when, out of the eight M. A. C. point winners in the intercollegiate athletic meet, five were men who were new to track contests; yet each one of these five was a winner of first place in his event.

We shall make it a part of our work to continue to develop new men in all lines of athletics.

Foot ball, basket ball and base ball were engaged in during their respective seasons, and while we did not win from an intercollegiate standpoint in these sports, we had a successful season in that there were a large number of men regularly engaged in healthful and stimulating athletic games.

During the year over four hundred dollars' worth of gymnasium, measuring and examining and athletic apparatus was purchased and used.

The beginning of the winter term saw over a hundred young men, mostly upper classmen, voluntarily taking regular exercise in the armory. This work continued until the last half of the term, when, on account of military drill beginning again for all, many of the young men dropped out, giving as a reason that they did not have time for both.

During the two half terms that the freshmen were drilling alone, they received a twenty minute drill for body building and straightening.

Regular indoor training for all spring athletics, including base ball, was carried on during the entire winter term.

Just after the intercollegiate field day I measured and examined the

M. A. C. winners with a special view to making a study of the physical characteristics of athletes. This requires a comparison with the average measurements of leading universities and colleges, and is not yet completed. I hope, however, to present you with the full results in the near future.

The young women received systematic physical training three hours a week during the three terms. This consisted of free work, dumb bell drill, wand drill, Indian club, marching, jumping and basket ball. Only two outside games of basket ball were played by the women, both of which were with the Lansing High School team of young women, both being won by M. A. C.

In closing, allow me to thank you and the Board for the hearty and generous support accorded this department.

Respectfully submitted,

CHAS. O. BEMIES.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1900.

REPORT OF SUPERINTENDENT OF INSTITUTES.

To the President:

I submit herewith a report on the institute work accomplished in the State, under the supervision and control of the State Board of Agriculture, during the year ending June 30, 1900:

The detailed report, including a full report of the addresses and discussions at the State Institute at Ann Arbor, financial statements, and statements as to the numbers in attendance at the county two-day institutes and the one-day meetings, with other statistical data, is published in a separate volume, which is sent out to the members of the County Institute Societies directly from the office of the Secretary of State.

The general plan of institute work adopted by the Board some years ago has been carried forward during the past year. This plan involves the co-operation of local societies, which are served by officers who are unpaid. I am glad to report that in general the work of these officers has been well performed. These men have given their time and not infrequently their money as well, for the furtherance of the local society. They have displayed energy and a degree of self-sacrifice rarely found. Without this intelligent and effective co-operation to supplement the funds appropriated by the State, it would be impossible to extend the work over the broad area at present covered. It is but just, in this connection, to record the grand work done in Allegan county.

In this county the local society has held sixteen institutes in the several townships, with good attendance and interest.

In the selection of workers it has been the policy to secure successful

farmers from the section of the State having as nearly as possible the same climatic and soil conditions as those existing in the county where the institute is held. When men go to a distant part of the State they can hardly adjust their experiences to the conditions existing near the institute. It is necessary also that the speakers shall be farmers, both successful financially and accustomed to practicing the best systems of agriculture.

Sixty-four two-day institutes were held in as many counties. Of one-day meetings there were eighty-two. The attendance averaged 160 per session as against 158 the year previous. The one-day work is being carried farther and farther back from the large villages and the attempt is made to interest farmers who have few advantages in the way of meeting their fellows or studying from a scientific standpoint the problems with which they are confronted. Naturally, in these so-called back districts, large audiences are impossible, and the size of the audience is no measure of the value of the meeting to the progress of the community. Owing to the high price of lumber the farmers went early into the woods in the fall of 1899, and the attendance at the meetings in the northern part of the lower peninsula was small.

The weather was not bad on the dates of most of the meetings and the attendance throughout southern Michigan was eminently satisfactory where the advertising had been properly done. There is a marked tendency toward specializing on the part of farmers and a call for better and more thorough discussion of special topics by the workers. This tendency is one to be encouraged. It has, however, increased the difficulty of getting workers sufficiently trained. In fruit sections, methods of fighting insects and fungus enemies have taken the place formerly occupied by general discussions of the relative advantages of the various kinds of fruits. Where mixed farming prevails there are calls for specialists along lines of live stock or special crops.

Institutes were planned in all counties in the State except Baraga, Delta, Dickinson, Gogebic, Houghton, Kalamazoo, Keweenaw, Leelanau, Mackinac, Marquette, Missaukee, Montmorency, Ontonagon, Presque Isle, Roscommon and Schoolcraft, in none of which an institute society was organized.

Four one-day meetings were held in Alcona, Berrien, Branch, Calhoun, Eaton, Huron, Ingham, Isabella and Oakland counties; three one-day meetings in Charlevoix, Gratiot, Hillsdale, Livingston, Manistee, Mason, Montcalm and St. Clair counties; two one-day meetings in Barry, Bay, Grand Traverse, Jackson, Kalkaska, Newago and Van Buren counties; finally the following counties had but one-day meetings each: Alger, Cass, Delta, Iosco, Emmet, Genesee, Luce, Midland, Muskegon and Ottawa. One-day meetings were therefore held in thirty-four counties.

The State Board of Agriculture accepted the invitation of the Washtenaw County Society to hold the sixth annual State Round-up Institute at Ann Arbor, beginning February 27 and ending March 2, 1900. Unfortunately, a violent snow storm set in at the beginning of the second day, rendering both the railroads and highways impassable. The railroads gave a rate of one fare for the round trip. The people of Ann Arbor and the President and other officers of the University made ample preparation for the care of visiting delegates and the welfare of the institute in general. Convenient, commodious and well-lighted halls were provided.

The attendance, considering the weather, was most satisfactory, and the proceedings interesting and instructive. A full report of the addresses and discussions is now in the hands of the printer.

One new and important feature of the convention was the conference of county secretaries, brought together by invitation of the Board to consider matters relating to the institutes of next year. Adjacent counties were grouped in such a way as to economize the time of workers and the funds of the State, and methods and means were as fully discussed as time allowed.

The Farm Home Reading Circle, supported financially out of the institute fund, has increased in membership and usefulness during the past year in a very satisfactory manner. Through the institutes, and by means of circulars sent through the mail, it has been well advertised. A new circular has just been issued introducing to members the best of the new books on topics related to agriculture. These books are being ordered freely and are widely read by Michigan farmers and their families. As agriculture becomes more and more specialized, the need of the instruction given by these books becomes correspondingly emphasized. It is a hopeful sign that farmers are appreciating this need and are taking the wisest course to satisfy it.

The State appropriation for the work of the year was $5,500, which was expended as follows:

Salaries	$2,689 05
Travel	2,397 17
Postage and printing	227 35
Incidentals	102 82
Farm Home Reading Circle	73 95
Freight	9 66
Total	$5,500 00

REPORT OF DEAN OF THE SPECIAL COURSES.

To the President:

I submit herewith a brief report of the special courses during the college year 1899-1900. There were offered five special courses as follows: The course in Creamery Management, in Live Stock Husbandry, in Cheesemaking, in Fruit Growing, in Greenhouse Management and in Beet Sugar Production.

All courses, except in cheesemaking and beet sugar production, began January, 1900. A change was made in the sequence of the courses this year, that in cheesemaking following the creamery course and immediately preceding the opening of the cheese factories in the spring.

The attendance upon the several courses was as follows:

Fruit	6
Cheese	17
Creamery	26
Live Stock	17
Beet Sugar	5
Total	71

These students came from all parts of Michigan, from New York and from as far south as Missouri and Arkansas.

While Michigan is not a State in which the larger part of the butter is made in creameries, it is true that the number of successful creameries is constantly increasing. I am glad to report that the very large minority of the successful creameries in Michigan are now managed by men who have attended our special course.

The cheese course was attended by as many students as our small room could comfortably accommodate. Notwithstanding the fact that the College has offered a cheese course but for a few years, it is unquestionably true that in a majority of the successful cheese factories of Michigan the cheese is made by men who have taken our cheese course. It is significant also that of the prizes competed for at fairs and the annual meetings of the State Dairy Association more than a full share falls to our former students.

There is a growing demand for young men well trained in judging and feeding live stock to manage large farms stocked with horses, cattle or sheep. I have to report that this demand now exceeds our supply and that I have several such calls for which the desirable young men are not forthcoming.

In the class in live stock husbandry this year were several men who own farms and herds and who felt the need of more thorough training along the lines offered. As the live stock interests of the State continue to develop this course will become a helpful factor in the education of owners and herdsmen.

The course in beet sugar production was offered during the first eight weeks of the spring term to meet the demands of young men for more thorough preparation in the chemistry of the sugar factory. The work of the course was made intensely practical, as each student was required to make repeated analyses of all juices, syrups, gases and other materials needing analysis in regular factory practice.

Through this course, as well as through the work of the Experiment Station, the College is proving an important factor in the introduction of profitable sugar making into Michigan.

Mr. E. L. Aderhold of Neenah, Wis., was again the very efficient instructor in cheesemaking.

Mr. R. E. Morrow of Elmira, Mich., a graduate of this College, class of 1898, and Mr. C. M. C. Scott of Romeo, Mich., a special student in creamery management in 1898, assisted in the instruction in the factory room and laboratories in the creamery and live stock courses.

Mr. Charles H. Spring of Grand Ledge, Mich., a senior in the mechanical course, gave the instruction in mechanics to the students in the creamery course.

Mr. A. N. Clark, assistant chemist to the Detroit Sugar Company, Rochester, Mich., gave instruction in factory management and chemistry to the special students in beet sugar production.

The financial statement in regard to the special courses shows an excess of disbursements over receipts of two hundred sixty-nine dollars, fourteen cents.

REPORT OF COLLEGE EXTENSION LECTURER.

President J. L. Snyder:

I hand you, herewith, a report of my work as College Extension Lecturer for the year ending June 30, 1900:

My work in this phase of my relation to the College is not clearly defined, but has been assumed both by yourself and the other officers of the College to be addresses at meetings of farmers in any part of the State when my other duties would permit.

The month of July, 1899, was spent very largely in California, as delegate to the American Association of Agricultural Colleges and Experiment Stations. On my return from that journey I visited the upper peninsula, accompanying the State Board of Agriculture in the matter of the location of the Upper Peninsula Experiment Station. The season during which the farmers' picnics are more often held began in the latter part of August. I submit below a partial list of the places visited in this work during the year named:

Aug. 18—Benton Harbor and Holland, sugar beet meetings.

Aug. 19—Gun Lake,, Allegan county, to address a farmer's picnic.

Aug. 22—Zeeland, Ottawa county, to talk on sugar beets and the dairy.

Aug. 31—Lawrence, Van Buren county, to address a meeting of creamery patrons.

Sept. 7—Barrytown, Mecosta county, to address a street fair.

Sept. 12—Curtis, Alcona county, at a summer institute.

Sept. 13—Gustin, Alcona county, summer institute.

Sept. 14—Haynes, Alcona county, summer institute.

Sept. 15—Caledonia, summer institute.

Oct. 14—Brooklyn, Washtenaw county, to address a farmers' club.

Oct. 25—Springport, Eaton county, a meeting of farmers.

Oct. 26—Grand Rapids, annual meeting of the State Health Association.

Nov. 1—Springport, annual meeting American Black Top Merino Association.

From the middle of November to the first of March my time was devoted to planning institutes, the work of the special courses, and addresses at institutes. After that time, the meetings have been as follows:

Mar. 8—Wheatland, Hillsdale county, an evening meeting of farmers and families.

Mar. 17—Special institute work at Edwardsburg on Fertility of the Soil, and Live Stock.

Mar. 21—Jerome, Hillsdale county, a dairy meeting.

Mar. 23—Battle Creek, an evening lecture to farmers and their families.

Mar. 27—Ganges, Allegan county, meeting of fruit raisers.

Apr. 4—Salem, Washtenaw county, dairy meeting.

Apr. 6—Tipton, Lenawee county, dairy meeting.

May 3—Howell, Livingston county, meeting of farmers' club.

May 11—Fitchburg, Ingham county, Pomona Grange.

May 26—Albion, Calhoun county, creamery meeting.

May 31—Pewamo, Ionia county, commencement address of the high school.

June 2—Linden, Oakland county, joint meeting of farmers' club.

June 5—Byron Center, creamery meeting.

June 16—Henrietta, Eaton county, meeting of farmers' club.

June 20—Silver Creek, Berrien county, creamery meeting.

June 21—Battle Creek, meeting of farmers and families, evening lecture.

June 22—Church, Hillsdale county, meeting of farmers and families, evening lecture.

June 28—Alpena, Alpena county, farmers' picnic.

The above lists do not include addresses given under the auspices of the Farmer's Institutes, except where they are so stated.

Through the kindness of the railroads I am permitted to travel to and from these meetings without cost of transportation. I desire to report that I have tried to make these meetings as instructive along purely agricultural lines as possible. The meetings of clubs and granges have been especially so. At the picnics the work has necessarily been of a different character, but still helpful in matters pertaining to the home and the education and training of the children.

If more of this work could be done in the winter, when farmers have more time to attend, it could be made to supplement the work of the institutes in a very helpful manner. There is needed a systematic course of lectures on what might be called the fundamentals of agriculture and agricultural practice, and such a systematic course can be given in the winter only. My opportunities of observation being exceptionally good, I am glad to report that the work of the farmers' organizations is paving the way very rapidly for a more extended knowledge and a wider view of agricultural problems on the part of the older generation of farmers, and at the same time in aiding materially in fitting the younger generation of farmers for the more intense competition and the harder battles of the future.

I am glad therefore to report that this phase of the College work is both opportune and helpful.

Respectfully submitted,

C. D. SMITH,

Superintendent of Institutes, Dean of Short Courses and College Extension Lecturer.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1900.

REPORT OF THE CURATOR OF THE GENERAL MUSEUM.

To the President:

SIR—I have the honor to submit the following report of the condition of the General Museum for the year ending June 30, 1900:

The collections in the main hall of the museum have undergone little change since my report of a year ago, and most of these changes have been for the better. I have to call attention to the fact, however, that several of the large specimens which are not under glass, but exposed in the open hall, have suffered noticeably from mutilation by visitors as well as from the exposure to dust and museum pests. This is particularly true of the large and small grizzy bears, and the elephant skeleton, and in a lesser degree of the Glyptodon cast and the head of the Elephas ganesa. Several of the claws have been torn off the bears, the elephant skeleton has been disfigured by the writing of names on the bones, and the plaster casts have been marred in a similar way and by scratching and boring with pen-knives, apparently in the attempt to discover their composition. A still more annoying piece of vandalism is the writing of names, dates or mere scrawls on the glass doors of the cases themselves, necessitating in some cases the replacing of the large panes. Probably few if any of these acts can be attributed to the students of the College; they are new to the history of the museum and are perpetrated doubtless by irresponsible persons who take advantage of the crowds which throng the place during the annual excursions or slip in unnoticed at other times. It is absolutely necessary that all specimens bearing hair or feathers should be placed within insect-proof cases, and the same should be done with the skeletons. The only alternative would be to close the museum except at times when an attendant could be kept on the watch, which would seriously limit the usefulness of the collections, and would be a hardship to a very great majority of the visitors to the College.

During the year the bird collection has been carefully overhauled and catalogued, this being the first work on a general card catalogue of the entire museum collection. The mammals have been carefully examined also, and all infested specimens have been treated. The additions to the museum were not so numerous as usual, perhaps, during the year, but the collections have made steady growth, particularly in much-needed local specimens. Thus mounted specimens of seven species of Michigan birds new to our collection have been added, and we have also collected many salamanders, frogs, tortoises, snakes, etc.

Among the more noteworthy accessions should be mentioned an unusually fine specimen of the Canada lynx, secured and donated by Mr. Wm. M. Snell, of Sault Ste. Marie, and finely mounted by the late Percy Selous of Greenville; a pair of fine seal-skin Esquimaux boots, from Behring Straits, presented by Leon J. Cole; a fine golden eagle, purchased alive and afterward mounted; a set of three Harvard geographical models, and a small but very accurate relief map of the United States; both the latter purchased especially for illustrating the work for the class in physical geography.

The work, begun two years ago, of substituting wooden blocks for cork in the insect collection, has progressed satisfactorily and is now almost completed, more than four-fifths of the insects having been transferred and rearranged already. About one-half of the beetles and a few cases of the smaller orders alone remain to be transferred. The additions to the insect collection during the year have been too numerous to specify, but hundreds of important species have been added, and many important gaps have been filled. For lack of time and assistance the matter of re-labeling the marine invertebrates has been delayed, but will be completed before another commencement. It is also expected that we may be able to rearrange and re-label the rocks, minerals and fossils, of which the museum now has a very fair exhibit if it could be properly displayed; this however will not be practicable until we have a new building or more commodious quarters.

WALTER B. BARROWS,
Curator of the General Museum.

REPORT OF THE LIBRARIAN.

To the President:

SIR—I have the honor to present the following report on the Library for the year ending June 30, 1900:

There have been 344 bound volumes added to the library during the year, of which 116 came by purchase, 161 by binding, and 67 by gift. Three hundred and ten pamphlets and unbound volumes have been received, nine of which were purchased.

All gifts to the library were acknowledged when received. Individual mention is therefore omitted.

One hundred thirty-one publications, both foreign and American, are purchased by the College, for use of students.

The following are donated or received in exchange:

Adrian Times.
Albion Recorder.
Allegan Gazette.
Agricultural Epitomist.
Agricultural Gazette, N. South Wales.
American Bee Keeper.
    Creamery.
    Horsebreeder.
    Horticulturist.
    Phil. Society Proceedings.
    Swineherd.
Baltimore Sun.
Battle Creek Journal.
Capital City Democrat.
Church Helper.
Corn Belt.
Detroit Free Press (Twice-a-Week).
Evening News (Saginaw).
Farm and Fireside.
Farmer's Voice.
Farming.
Farm, Field and Fireside.
Farmers' Advocate.
    Home.
    Guide.
    Journal.
Farm and Home.
Farm Journal.

Fruit Growers' Journal.
Good Health.
Grand Traverse Herald.
Grand Rapids Herald.
Democrat.
Grange Bulletin.
Homestead.
Hillsdale Leader.
Standard.
Home Companion.
Hoard's Dairyman.
Home and Farm.
Indiana Farmer.
Industrialist.
Ingham County News.
Ionia Sentinel.
Jonesville Independent.
Journal of Agriculture.
Kalamazoo Telegraph.
Lansing Journal (daily).
Land of Sunshine.
Literary News.
Mark Lane Express (London).
Michigan Fruit Grower.
Monthly Weather Review.
Michigan Mirror.
Mirror and Farmer.
Michigan Advocate.
Monthly Bulletin Vital Statistics (Mich.).
Moderator.
New England Florist.
N. Y. Weekly Witness.
National Stockman and Farmer.
Otsego County News.
Onekama Lake Breeze.
Oregon Agriculturist.
Orange Judd Farmer.
Official Gazette.
Public Ledger (Phila.) daily.
Pratt Institute Monthly.
Park's Floral Magazine.
Practical Farmer.
Proc. Amer. Soc. Civil Engineers.
Queensland Agricultural Journal.
Rhodora.
State Republican (daily).
Sault Ste. Marie News.
Sugar Beet.
St. Ignace News.
Salt Lake Herald.
Sound Currency.
Travelers' Record.
Traverse Bay Eagle.
Voice.
Western Agriculturist.
Plowman.
Wallace Farmer.
Western Society of Engineers.
Williamston Enterprise.
Ypsilantian.

The M. A. C. Record exchanges are also placed in the reading room, and in exchange for our catalogue, the library receives the year books, catalogues or registers from all the leading educational institutions of the country. We also receive the bulletins of the various experiment stations.

During the year 6,249 books have been loaned (no record is kept of books used in the library), and $26 has been collected on account of fines.

To the Experiment Station library 79 books have been added, three by purchase and seventy-six by binding. This library now contains 1,894 bound volumes; the College library now numbers 19,688 volumes; total, 21,582.

Respectfully submitted,

MRS. LINDA E. LANDON,

Librarian.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1900.

ANNUAL REPORT OF MICHIGAN WEATHER SERVICE FOR THE YEAR ENDING JUNE 30, 1900.

To the State Board of Agriculture:

GENTLEMEN—The service has continued under the immediate charge of Mr. C. F. Schneider, who is detailed by the Chief of the U. S. Weather Bureau. The headquarters' office is in the Federal building at Lansing. No particular new work has been taken up during the year, the energy of the central office being directed principally along the line of improving the observation service and the distribution of the daily forecasts, frost and cold wave warnings.

VOLUNTARY OBSERVING STATIONS.

The total number of voluntary observing stations at the close of the year was 116, a net gain of seven during the year. With but very few exceptions the stations have made daily observations and reported monthly. As a whole the work of the voluntary observer has been very efficient and satisfactory. The instrumental equipment of the stations is an instrument shelter, maximum thermometer, minimum thermometer and rain gauge. In some cases padlocks have been furnished for locking the instrument shelters. During the closing months of the year eight new stations were established in the upper peninsula, one of them being located on Isle Royale. The immediate object of these additional stations was the collection of precipitation statistics of the Lake Superior basin.

Since the opening of the Chicago drainage canal and the rapid forwarding work in the Soo water power canal the matter of our lake levels has become exceedingly important, not only to the vast shipping interests afloat upon them, but particularly to Michigan, which derives much of her wealth and livelihood from the commerce afforded by the lakes. The matter of lake levels has been a subject of considerable conjecture, but this service hopes that it will soon obtain abundant and reliable rainfall and snowfall statistics that will greatly aid in solving many perplexing questions connected with the lake levels.

The service has also established several new stations in the great sandy barrens of the northeastern portion of the lower peninsula. Data from them will undoubtedly prove valuable in the study of the great problem of utilizing that waste tract.

The appropriation which the State makes for the equipment of these stations is barely sufficient to meet present needs; we have, however, been able to fully equip all stations. The problem which now confronts the service is the maintenance and repair of the instrumental equipment. The instrument shelters when first furnished had two coats of white lead and oil; weathering of two or three years' time wears this coat of oil and lead badly and in the interest of economy they should all be thoroughly repainted; this will cost not less than $2.50 per shelter, and for 116 shelters $290. The small appropriation which the service has at its command does not allow us to do this work very rapidly;

it is, however, the intention of the present director to have about half of the shelters repainted during the present year.

The matter of the inspection of stations is another very important item when it is considered that these 116 observers do their work daily, which includes all holidays, without any compensation whatever from the State or government, the wonder often is how so much good work is obtained. The observers are in most cases laymen who are not familiar at first with the technical insight of meteorological work which is necessary to make their observations a success. For this reason a personal visit from the director is often necessary to start the work properly or to correct a poor exposure of the instruments which has resulted in allowing the voluntary observer to use his own judgment. Besides this, thermometers weather so badly that the calibration marks become obliterated in the course of about a year and very often the straps holding them on the metal back corrode. For these reasons an inspection of some one from the central office is of great value in improving the record. As far as the funds would permit the director has inspected the voluntary observing stations during the past year and in every case the value of the inspection has been apparent in the next report rendered.

FORECAST DISTRIBUTION.

The number of forecast distributing centers in charge of this office is 56, and the number of addresses furnished is 4,574. Besides this, there are 26 display stations, of which 22 are flag and four whistle signal stations.

Eight hundred and thirty-three railroad stations display the forecasts in their waiting rooms.

The rural mail delivery system which is growing very rapidly is doing more than any other agency to distribute the forecasts to the farmer. During the past year we have established six new forecast distributing centers for the distribution of forecasts along the rural mail routes. Arrangements have been made with the postmasters at the termini of these rural routes to receive a telegraphic forecast message every morning and then by means of a logotype stamping outfit, to transfer it to a large number of paper slips. A sufficient supply of these slips is then handed to the rural mail carrier who leaves one in each rural box which he passes. The rural carrier touches most of these boxes before 2 p. m., so that they are able to inform the farmer regarding the weather probabilities for "tonight and tomorrow" as soon as most of the large city addresses now receive them. This service has called forth the highest commendation from our rural patrons and we are now actively engaged in extending the work and hope by the beginning of the next agricultural season to have a very large rural forecast delivery service in operation.

WEEKLY CLIMATE AND CROP BULLETIN.

As in previous years this office has issued during the planting, growing and harvesting season a weekly climate and crop bulletin, which describes briefly for the State and for each county, the weather conditions of the past seven days and their effect on the progress of the various staple crops and field work. The bulletin continues to be published weekly in the metropolitan and smaller newspapers and is a very popular feature of our work.

MONTHLY CLIMATE AND CROP BULLETIN.

A monthly bulletin containing a statistical meteorological resume for each station, besides a small amount of explanatory text, has been issued monthly during the year. The text refers specifically to the statistical tables and also has contained timely and kindred scientific matter which is published editorially. The data thus compiled is much referred to and by a varying class of interests. Besides this the central office has prepared 60 tables calling for specific meteorological data at special points.

The record of observations made throughout the State is rapidly becoming valuable to our people. As they become better acquainted with this office and the resources which it contains our meteorological data is brought more and more into use and by nearly every class of business done within the State.

CONCLUSION.

The work of the Michigan Weather Service in all respects has made favorable progress and the only recommendation I have to make to your honorable Board is for a slight increase in the appropriation which will enable us to keep the instruments in better repair and which will allow of a more frequent and general inspection of stations. Both of these subjects are vital to the attainment of best results. It is much cheaper to repaint an instrument shelter than to replace it, and a personal visit from the central office often will correct a serious error of exposure or manner of doing the observation work that any amount of correspondence would not have discovered. Besides, a closer relationship is established between the voluntary observer, who serves entirely without pay and solely on account of his enthusiasm for the work, and the central office, which relies entirely upon the good work of the voluntary observer for the success of the service in the State.

Very respectfully,

C. F. SCHNEIDER,

Director.

LANSING, MICH.,
June 30, 1900.

REPORT OF THE STATE INSPECTOR OF NURSERIES.

To the State Board of Agriculture:

Hon. T. F. Marston, President—

As State Inspector of Nurseries and Orchards, I make the following report of the amount and condition of San Jose scale and other injurious insects and diseases found in the orchards of Michigan, and of the work done for the year ending June 30, 1900, in compliance with act 137, laws of 1897.

Another year's work with the San Jose scale still keeps it confined to five small colonies, situated in as many different counties. Here it has been kept from spreading, but has not been exterminated, owing to the lack of necessary materials for fighting it.

One of the five colonies reported last year has been taken off the list, but another found this year takes its place.

The scale was not found in any of the nurseries of the State, and there has been no complaint from dealers receiving infested stock from outside growers. Last year there were several such reports.

Another very injurious scale, determined by Prof. R. H. Pettit to be Aspediotus ostraeformis (European Fruit Scale), has been found in many places in the West Shore Fruit Belt. The extent of damage done in each of the cases has not been carefully worked up yet, but will be the coming year. A number of colonies have been sprayed and results are being carefully watched for.

One hundred and twenty-five orchards have been examined and not one case of scale found. The colony mentioned before was located by specimens being sent to Prof. L. R. Taft.

The "Canker Worm" is very bad and increasing rapidly, doing a great amount of damage. My efforts to get men to spray, and in getting commissioners appointed to assist in forcing others to spray, have only been partially successful. However, some good has resulted from the labor done, for the orchards sprayed have been a good object lesson to those who would not spray, and consequently have had their orchards bare of foliage, thereby losing all their apples. Next year I hope to report more progress in stopping the ravages of this pest. The past season has forced many to see that something must be done and that quickly.

During the year I inspected fifty-five nurseries, the stock of twenty-five fruit growers, and the premises of five dealers.

The number of licenses issued are the same as last year, but a number of new names appear on the list, others going out of the business. Many of the dealers have to be forced to get their licenses.

The nurseries of the State still fail to show any indication of the presence of San Jose scale, or the new fruit scale determined by Prof. Pettit. Black aphis on the roots of the peach was found in several large blocks of trees. These trees were thoroughly fumigated. Woolly aphis on the stem and roots of the apple was found in small quantities in several places; this stock was also fumigated. One small block of

peach trees was badly infested with crown gall; the trees were destroyed.

Very little stock has been received into the State not having the necessary inspection certificate attached. Two suspicious shipments were examined, but they were not infested with anything injurious.

The above, together with a large amount of clerical work, has taken all my time.

Respectfully submitted,

D. W. TRINE,

Inspector.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1900.

NURSERYMEN.

The following is a list of nurserymen and dealers who had licenses from June 30, 1899, to June 30, 1900:

Allen Nursery Co., W. E.	Kalamazoo, Michigan
Allen Nursery Co.	Rochester, New York
Bowman & Son, Thos. W.	Rochester, New York
Bragg & Co., L. G.	Kalamazoo, Michigan
Buttrick & Beebe	Cascade, Michigan
Brown Bros.	Rochester, New York
Bogue, Nelson	Batavia, New York
Baldwin, O. A. E.	Bridgman, Michigan
Biglow, J. N.	Bangor, Michigan
Bryant Bros.	Dansville, New York
Central Michigan Nursery Co.	Kalamazoo, Michigan
Chase Bros. Co.	Rochester, New York
Chase Co., The R. G.	Geneva, New York
Cole, W. B.	Painesville, Ohio
Curtis, L. P.	Flint, Michigan
Carlton Nursery Co.	Rochester, New York
Chautauqua Nursery Co.	Geneva, New York
Dunham, Enos W.	Stevensville, Michigan
Davis & Brother	South Haven, Michigan
Dean, Geo. N.	Shelbyville, Michigan
Dressel Bros.	Hart, Mich.
Day, John	Fremont, Ohio
Ellwanger & Barry	Rochester, New York
Essig, W. W.	Detroit, Michigan
Emmons & Co.	Newark, New York
Empire State Nursery Co.	Waterloo, New York
Fox & Son, John	Woodland, Michigan
Flansburg & Peirson	Leslie, Michigan
Flemer & Flemly	Springfield, New Jersey
Foote, O. C.	Ogden, Michigan
Greening Bros	Monroe, Michigan
Gustin, C. F.	Adrian, Michigan
Goodell, E. W.	Mayville, Michigan
Havekost, Geo. H.	Monroe, Michigan
Herrmann, H. A.	Monroe, Michigan
Hawley & Sons, E.	Hart, Michigan

Hamilton, A.	Bangor, Michigan
Husted & Co., N. P.	Lowell, Michigan
Hoppin, A. D.	Bangor, Michigan
Ilgenfritz' Sons, I. E.	Monroe, Michigan
Johnson, W. W.	Snowflake, Michigan
Jeffries, James	Kalamazoo, Michigan
Jaquay & Co., Irving.	Benton Harbor, Michigan
Kellogg, R. M.	Three Rivers, Michigan
Knight & Bostwick.	Newark, New York
Lampson & Rood	Covert, Michigan
Lewis, A. E.	McCords, Michigan
Maudlin, E.	Bridgman, Michigan
Maple Grove Nurseries	Waterloo, New York
Michigan Nursery Co.	Monroe, Michigan
Nelson & Son, J. A.	Paw Paw, Michigan
Northern Orchard & Nursery Co.	Augusta, Michigan
Pickett, G. S.	Clyde, Ohio
Prater, G. E.	Paw Paw, Michigan
Peirson Bros	Waterloo, New York
Proctor, J. R.	Caledonia, Michigan
Rakestraw & Pyle	Willowdale, Pennsylvania
Stewart & Co., C. W.	Newark, New York
Spielman Bros	Adrian, Michigan
Stone & Son, John	Hillsdale, Michigan
Sweet & Co., John	Dansville, New York
Sherwood, E.	Odessa, New York
Van Dusen Co., The C. L.	Geneva, New York
West Michigan Nursery Co.	Benton Harbor, Michigan
Weston & Co., A. R.	Bridgman, Michigan
Wise, Ralph	Otsego, Michigan
Whitten, C. E.	Bridgman, Michigan
Wooll, I. A.	Elsie, Michigan
Whitney & Co., G. W.	Dansville, New York

DEALERS IN NURSERY STOCK.

Augustine, L. D.	St. Joseph, Michigan
Archer & Co., Thos.	St. Joseph, Michigan
Bailey, H. A.	Jackson, Michigan
Ball, Du Bois Nursery Co.	Battle Creek, Michigan
Bouske, A.	Marine City, Michigan
Briscoe, J. A.	Detroit, Michigan
Baldwin & Co., C. E.	Augusta, Michigan
Culver, O. B.	Colon, Michigan
Clark, D. H.	Holland, Michigan
Davis, S. B.	Jackson, Michigan
Dow, H. C.	Bravo, Michigan
Filer, A. C.	Calumet, Michigan
Green & Son, A. W.	Michigan Centre, Michigan
Grand Rapids Nursery Co.	Grand Rapids, Michigan
Hill, Wilson	Davidson, Michigan
Horton, D. D.	Greenville, Michigan
Ilgenfritz & Co., E. C.	Monroe, Michigan
Lewis, Geo. H.	Monroe, Michigan
Ludwig, W. E.	Lake Odessa, Michigan
McGrayne, Fell & Co.	Detroit, Michigan
Owen, R. B.	Battle Creek, Michigan
Perry, J. W.	Birmingham, Michigan
Pilkinton, S. H.	Portland, Michigan
Perkins, H. D.	Grand Rapids, Michigan
Reynolds, Chas.	Lowell, Michigan
Stone, J. B.	Vermontville, Michigan
Souter, Geo. H.	Holland, Michigan
Thrasher, C. D.	Hamburg, Michigan
Trask, F. M.	Williamston, Michigan
Wells, Albert	Saranac, Michigan

THIRTEENTH ANNUAL REPORT

OF THE

EXPERIMENT STATION

OF THE

STATE AGRICULTURAL COLLEGE OF MICHIGAN

UNDER THE HATCH ACT

FOR THE

YEAR ENDING JUNE 30, 1900

For members and organization of the State Board of Agriculture in charge of the Station, and list of officers, see page 8 of this volume.

EXPERIMENT STATION.

REPORT OF SECRETARY AND TREASURER.

The following account shows the receipts and expenditures of the Experiment Station for the year ending June 30, 1900:

		Dr.	Cr.
July 1, 1899—To	balance on hand	$895 66	
July 6, 1899	received from U. S. Treasury	3,750 00	
Oct. 9, 1899	received from U. S. Treasury	3,750 00	
Jan. 6, 1900	received from U. S. Treasury	3,750 00	
April 6, 1900	received from U. S. Treasury	3,750 00	
June 30, 1900	license fees on 81 brands commercial fertilizers	1,620 00	
	miscellaneous receipts, mostly farm products	586 64	
	miscellaneous receipts, South Haven	257 52	
June 30, 1900—By	disbursements as per vouchers filed in the office of the State Auditor General	....	$17,872 38
July 1, 1900	balance on hand	....	487 44
		$18,359 82	$18,359 82

From twenty-five to thirty-five thousand copies of station bulletins are now issued, and the demand is increasing as farmers learn of their value. Several press bulletins have been issued and special information in bulletin form has been sent out by the station.

DISBURSEMENTS ON ACCOUNT OF U. S. APPROPRIATION.

Salaries:		
Assistants to scientific staff, No. 5	$1,854 56	
Director and administrative officers, No. 6	2,193 99	
Scientific staff, No. 7	4,771 50	
		$8,820 05
Labor:		
Monthly employes, 2; average rate, $20.50	$246 00	
Daily and hourly employes	2,353 25	
		2,599 25
Chemical supplies:		
Chemicals		272 01
Half tones, mailing list, etc.	$324 52	
Bulletin envelopes and reports	386 83	
		711 35
Carried forward		$12,402 66

Brought forward		$12,402 66
Seeds, plants and sundry supplies:		
Agricultural	$223 59	
Horticultural	192 80	
Miscellaneous	82 27	
		498 66
Tools, implements and machinery:		
Repairs	$37 90	
New purchases	71 36	
		109 26
Furniture and fixtures:		
1 wintering case, bees	$11 10	
Sundry fixtures	6 50	
		17 60
Scientific apparatus:		
1 polariscope	$154 45	
1 apochromatic objective	73 75	
Sundry items	277 74	
		505 94
Live stock:		
Cattle	$44 43	
Swine	39 38	
Sundries	4 75	
		88 56
Traveling expenses:		
In supervision of station work		270 86
Contingent expenses		2 00
Building and repairs		3 84
Postage and stationery		501 36
Freight and express		199 13
Fertilizers		51 62
Feeding stuffs		131 85
Library		216 66
Total		$15,000 00

DISBURSEMENTS OF EXPERIMENT STATION—MONEYS OTHER THAN RECEIVED FROM UNITED STATES TREASURER.

Salaries	$711 98	
Labor	1,459 18	
Publications	3 87	
Postage and stationery	24 58	
Freight and express	6 86	
Seeds, plants and sundry supplies	369 81	
Fertilizers	35 68	
Tools, implements and machinery	24 61	
Feeding stuffs	112 40	
Chemical	34 97	
Heat, light and water	7 10	
Traveling expenses	81 34	
		$2,872 38
Balance on hand		487 44
Total		$3,359 82

REPORT OF THE DIRECTOR.

To the President:

There have been issued in the year ending June 30, 1900, the following bulletins:

No.	Title.	Author.	Department.	Pages.
174	Fertilizer Analyses	R. C. Kedzie	Chemical	12
175	Some Insects of the Year 1898	R. H. Pettit	Entomological	33
176	Strawberry Bulletin	L. R. Taft and H. P. Gladden	Horticultural	14
177	Report of South Haven Sub-Station	L. R. Taft and S. H. Fulton	Horticultural	42
178	Wool Bulletin	H. W. Mumford	Agricultural	48
179	Sugar Beet Investigations	J. D. Towar	Agricultural	23
180	Insects of the Year 1899	R. H. Pettit	Entomological	29
181	Soil Tests on Uplands and Muck.. Clover and Lucerne Notes Wheat Experiments	J. D. Towar	Agricultural	23
182	Pure Milk Supply	C. E. Marshall	Bacteriological	18
183	Gassy Curd and Cheese	C. E. Marshall	Bacteriological	12
184	Tuberculosis and Its Management	C. E. Marshall	Bacteriological	59

One special bulletin has been issued in the same period, making the thirteenth in that series. It was entitled, "A Review of Prof. Bang's Work with Contagious Abortion," and was written by C. E. Marshall.

I am very glad to report that there has been no change in the working force of the station during the year except the resignation of Prof. W. B. Barrows as consulting entomologist and the promotion of R. H. Pettit to that work.

The reports of the heads of the various divisions and the bulletins which are submitted herewith will give a more accurate idea of the work of the station during the year than can any report compassed within the narrow limits that could reasonably be allowed me.

In the agricultural division much attention has necessarily been given the subject of sugar beets. Nine sugar factories were in operation during the last campaign, and another may be expected to commence work in the early fall of 1900. The season of 1898 was on the whole decidedly favorable for the production of a large crop of beets at a good profit to the grower. The season of 1899, on the contrary, was not one that allowed a large yield. As a result of this sequence of seasons many farmers who had been induced to contract with factories for a large acreage in 1899 suffered no inconsiderable pecuniary loss from the season's transaction. They had been induced to go into the raising of beets by the success of farmers about Bay City the year previous. The Experiment Station sent out a large amount of seed in the spring of 1899 to selected farmers who would consent to raise an area of at least a quarter acre, keeping careful watch of the incidents of the growth of the crop, and keeping a record both of the items of expense and return and the observations made. The results of the analyses of the beets sent in confirm the work of previous years and demonstrate conclusively that there are no counties in the State south of a line drawn east and

west through the northern boundaries of Mason and Arenac counties that do not contain large areas well adapted to the growing of beets.

As to the soil to be selected for beets the experience of 1899 goes to show that in a very dry season a soil containing considerable clay produces a much larger and better crop than one too sandy. The clay soils must, of course, be fairly rich in organic matter and in a high state of culture. Sandy soils, while easily penetrated by the roots of the beets, dry out too readily unless well filled with decaying organic matter. I call attention to the investigations of Prof. Towar as reported in bulletin 179, which follows.

The investment of the large amount of money in the sugar factory shows that the raising of beets in Michigan has passed beyond the experimental stage, and the station in the future must devote its attention not to the question whether given localities can raise profitable beets, but to the problems involved in the production of the largest amount of sugar per acre without injury to the fertility of the soil. The fertilizer question is one of the earliest, therefore, to be undertaken. A careful watch is kept on the insect and fungus diseases of the crop, with results reported by Prof. Pettit in bulletin 180.

The experiments still continue with the leguminous crops mentioned in my last annual report. The sand lucerne has again maintained its good reputation. The agriculturist of the station has distributed seed of this valuable legume in selected localities of the State where it will be of most value. Our aim is to secure, if possible, some legume that will be reasonably certain to germinate and produce a crop of forage on the sandy soils of the State now lacking in organic matter.

The work on muck land continues with promise of important and valuable results. These experiments are scattered widely over the State, and the results will be predicated on trials under the widest variety of conditions.

Lack of funds has prevented the undertaking of experiments with live stock as was hoped at the beginning of the year. Prof. Mumford has conducted an investigation of the present status of the wool production in the State and the conditions which lessen the prices obtained for Michigan products. The appearance of a timely and valuable bulletin on the subject of Michigan wool cannot fail to be of great value to the sheep raisers. The work with the grade dairy herd has been brought to a conclusion in the spring of 1900. Much attention should be given to this work with live stock in the future. The sheep industry is menaced by a very serious evil in the form of stomach worms and nodular diseases of the intestines. For the latter no known remedy exists. No more promising field opens before the station than investigations looking toward the discovery of some easily applied but efficient remedy for this insidious disease. The call for work along the lines of hog cholera is not as pressing this year as last.

Prof. Marshall reports the conclusion of the work on tuberculosis. This line of experiments has cost the station a great deal of money, but the results justify the expenditure. This is not the proper place to review in detail the work accomplished. It is enough to say that a definite and important addition has been made to our knowledge concerning this disease, than which no more threatening and widespread exists today.

In the horticultural division the work of last year was continued. Spraying with Bordeaux mixture or copper sulphate solution has been, for leaf curl of the peach, continued with results the most satisfactory. The discovery of the cause of crown gall on the peach by Prof. Toumey of Arizona, a graduate of this College, lessens the danger to be apprehended from this disease, although as yet remedies are not forthcoming.

The work at the South Haven sub-station has proceeded very satisfactorily under the immediate supervision of Mr. Fulton.

By an act passed by the last legislature and approved by the governor in March, 1899, the State Board of Agriculture was authorized to establish a sub-station in the upper peninsula. This sub-station was by resolution of the Board placed in charge of the director and council of the Experiment Station.

The station was located by the Board of Agriculture in October, 1899, after a careful examination of proposed sites in many counties of the upper peninsula. The location chosen was at Chatham, on the Munising Railroad, eighteen miles southwest of Munising. One hundred and sixty acres of land was donated to the Board for this purpose by the railroad company, who engaged to clear certain portions of the land and fit it for experimental purposes in time for the beginning of experimental work in the spring of 1900.

Mr. Leo M. Geismar of Reed City was placed in charge of the station, and began work May 1, 1900. Experiments have begun with the cereals and garden vegetables.

Respectfully submitted,

C. D. SMITH,
Director.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1900.

REPORT OF THE AGRICULTURIST.

Prof. Clinton D. Smith, Director of Experiment Station:

DEAR SIR—I herewith submit the report of the Agricultural Department of the Experiment Station for the year ending June 30, 1900:

In the report submitted one year ago a general outline of the work in progress was given. The experiments therein enumerated have been conducted and are still continuing in accordance with their original plans. Since that time the care of the pine plantations has been turned over to the Farm Department of the College, leaving the other fields and work in the hands of this department as described in the former report.

CO-OPERATIVE SOIL TEST EXPERIMENTS.

The completion of these experiments in the fall of 1899, though in some cases somewhat disappointing and unsatisfactory, led to some very important conclusions in regard to the fertilizer question in this State.

The results of a single year's experiments of this nature is never conclusive enough to warrant the drawing of definite conclusions. Furthermore, the extreme drought of the summer of 1899 may have been the cause of the disappointments which followed the applications of fertilizers in some localities. The results, however, of this experiment are published in bulletin form, and some of the experiments are continued for another year. I take this occasion to thank the gentlemen who kindly conducted these experiments, and though all the experiments are not being continued it is generally the fault of the land, the location, or lack of time and funds that necessitated our dropping some of them this year.

These soil test experiments are being continued by Mr. L. B. Walton, Dryden, Lapeer county; Bruce Phillips, Utica, Macomb county; Glen C. Lawrence, Ypsilanti, Washtenaw county; A. E. Gregory, Dowagiac, Cass county; H. M. Kingsley, Kendall, Van Buren county; the Parmelee Farm, opposite the College grounds, Ingham county; and on the College farm.

SOIL TEST ON MUCK LAND.

The experiments on muck land in field 13 were carried through the season of 1899, using leached ashes, ordinary sand, air slaked lime, commercial and home mixed fertilizers, stable manure, wood ashes, and fertilizers, alone and in combination, to provide a test similar to that conducted on the uplands. The crops sown on this experiment included nearly all the annuals that would naturally be sown on this kind of soil. The results were as a rule very uniform, the largest yields generally being on the plots receiving stable manure. Very satisfactory results were obtained from applications of wood ashes, and other materials in which the mineral elements played a prominent part. Indeed, the leached ashes gave very satisfactory results in some cases, while the application of sand from the College gravel pit gave material increase in yield over the unfertilized plots. Thoroughly rolling the ground gave yields nearly as good as where liberal applications of commercial fertilizers were made. The importance of work in connection with muck land led to the inauguration of three experiments on portions of some of the large muck areas of the State. These experiments were begun this spring and are being conducted by Mr. C. R. Ferguson, Almont, Lapeer county, Mich.; Mr. A. M. Todd, Pearle, Allegan county, Mich., and by the Michigan Asylum for the Insane, Kalamazoo, Mich., on some of the Kalamazoo celery soil. These new experiments, occupying about thirty-three 1-20 acre plots, are receiving wood ashes, leached and unleached, air slaked lime, in varying quantities from two to four tons per acre and in combination with stable manure, commercial fertilizers and mixed manures. There are also plots devoted to salt, land plaster, and nitrate of soda, dissolved phosphate rock, potash salt in various combinations. Several nothing plots are inserted as checks, one of which is being thoroughly rolled to note the effect of packing this kind of soil. The crops sown are sugar beets, corn, onions, potatoes, mint, oats, carrots, and a few other roots and annual crops.

TESTING VARIETIES.

Varieties of wheat, corn, oats and clover have been tested the past year, the results of which will appear in bulletin form. The limited

area of land at the disposal of the Experiment Station stands in the way of satisfactorily conducting variety tests. A portion of the experimental grounds known as the Davenport plots have been appropriated for testing varieties of wheat and other crops. At present twenty of these plots are promising a very satisfactory test on sixteen varieties of wheat, Dawson Golden Chaff being sown as the check crop for the test. As a means of more extensively testing varieties of wheat we sent out to several farmers in the State the seed for conducting tests with wheat at the last seeding. The department furnishing the seed in this experiment, and the farmer promising to make a careful comparison of the varieties sent, together with those growing on his farm. It is hoped that by continuing a system of this kind some very reliable figures may be obtained.

SAND LUCERNE.

The very satisfactory results in the growth of this perennial legume have led to the expanding of the experiments and distribution of seed to about 150 farmers of the State. The plots of this crop were cut four times last year, the better plot yielding over five tons of hay per acre. We are experimenting this year on the value of this crop as a pasture plant, pasturing sheep in hurdles on a small area of it. A new seeding of one-half acre was made this year, and to the names of 150 farmers a quantity of seed was sent sufficient to sow five or six square rods, together with a letter of instruction. This plant is giving so much promise, especially in the dry sandy regions, that we hope for its universal adoption as a new hay crop in this State.

SAND VETCH.

The department is constantly receiving letters of inquiry relative to the characteristics of this plant. In order to learn something more of its value as a forage and hay crop, as well as its value as a green manure, the department has sent out about 120 packages of seed of this plant. After time enough has elapsed to give this a fair trial we hope to receive replies from the people who have it, and publish them in a future bulletin.

A large number of varieties of cow peas and soy beans were grown the past year. These are being grown again this year, with the idea of studying their feeding and fertilizing value, the results of which we hope to publish in a bulletin on legumes in the near future.

SUGAR BEETS.

The work of the past year in connection with the sugar beet growing was directed to the testing of varieties, the date and method of planting, distance apart of planting, and the use of fertilizers in connection with the crop. The fertilizer experiments were directed to determine not only the yield, but their effect upon the sugar content and purity of the beets. In this latter direction the chemist of the Experiment Station has heartily co-operated.

The experiments now in progress with sugar beets are in continuation of those begun one year ago. In our co-operative experiments on muck land especial attention is given to sugar beets under the various treatments to determine if it is possible to grow on our muck lands a quality

of beets that may be profitably sold for sugar manufacture. The results of last year's work with sugar beets are recorded in bulletin No. 179.

CLOVER.

An experiment intended to continue for several years, to determine the best time of year to sow clover seed, has been in progress for thirteen months. The plan is to sow clover seed on soil of uniform character and condition, continuing the experiment until there is a sufficient number of results that averages may be drawn. For the past season's work the results give a preference to a period between February 1 and July as the more desirable for seeding to clover. The ground was plowed and the clover sown alone without a nurse crop, the mowing machine being used two or three times during the first year to cut the weeds. Further reports in regard to this will follow in succeeding publications.

CURIOSITY STRIP.

This interesting plot of ground is being kept as a part of the Experiment Station fields, and is used to introduce new plants and to have at a convenient place many of the ordinary crops which are sown in various portions of the College farm. Last year the Australian Salt Bush made a very promising growth on this strip of land, and this year is being tried in larger areas on the College farm. Secaline, a perennial which has occupied the curiosity strip for several years, seems to be dying out, it having received its death blow during the cold weather of the winter of 1898 and '99. Peanuts were successfully grown last year on the sandy part of the curiosity strip and yielded in quantity sufficient to encourage us in further attempts to grow this crop here. Three varieties of tobacco were successfully grown on the curiosity strip in 1899, indicating the possibilities of growing this crop in Michigan.

A small portion of the time of the agriculturist has been given to planning experiments for the upper peninsula station and the purchase and shipment of tools and seeds for that place.

During the past winter eight weeks of the time of the agriculturist was consumed in attending Farmers' Institutes.

Respectfully submitted,

J. D. TOWAR,

Agriculturist.

AGRICULTURAL COLLEGE, MICH.,

June 30, 1900.

To the Director:

I have the honor to submit the following report of the work in experiments with live stock for the year ending June 30, 1900:

A bulletin on the "Production and Marketing of Wool" was completed and mailed by the station. As this bulletin appears in full elsewhere in the current report of the State Board of Agriculture it is unnecessary to speak of its contents.

We are still investigating this subject with a view of placing in the hands of the wool growers information which, if taken advantage of, will make it possible for wool growers of Michigan to get the highest market price for their wools.

We cannot say as yet whether or not enough information will be gathered to complete another bulletin. If not, some way will be planned to give the people the benefit of our investigations.

An experiment had been planned in testing the relative value of silage and shock corn for fattening steers, but for lack of funds the experiment had to be abandoned. We are now expecting to carry forward this proposed feeding experiment during the coming winter season.

We have been planning for some time a breed test with our principal breeds of sheep. Not a comparative feeding test, but by using a definite number of breeding ewes of each of the leading breeds of sheep and carrying them through for a year or more the relative cost of keeping the same would be indicated. We believe such an experiment would be of great value to our farmers. We know much more of the probable relative income from the different breeds than we do of the relative cost of keeping the same. One factor is as important as the other in deciding the relative profit of the different breeds in the farmer's hands, and we believe there will be less chance for misleading results in an attempt to fix upon an average cost of keep for a year, than upon the relative income. In an experiment of this nature the income from each breed might be noted. Funds are not available for carrying forward this experiment the coming year, but we trust it may not be delayed longer.

Respectfully submitted,

HERBERT W. MUMFORD,

Experimenter with Live Stock

AGRICULTURAL COLLEGE, MICH.,

June 30, 1900.

REPORT OF THE HORTICULTURIST.

Prof. C. D. Smith, Director:

SIR—I have the honor herewith to present the report of the work in the Horticultural Department for the past year:

With the opening of the year the resignation of Prof. H. P. Gladden, who had acted as assistant horticulturist for ten years, left the work in experimental lines at the College to be performed by Mr. Dean and myself. Before closing his connection with the College Mr. Gladden wrote up his notes upon strawberries for 1899 and they were published as a bulletin. The work for the season as outlined in my last report was carried through and plans were made to publish the results, but press of other work has made it impossible to prepare them for the printer.

During the spring a new plantation of raspberries has been made and the vacancies in the vineyards and orchards, caused by the winter of 1898-9, have been filled. The loss was almost total in the case of the older peach trees, and a very large per cent of the grapes also were killed. The wind storm of June 8 broke down many of the large trees in the apple and cherry orchards and overturned a considerable number of the young trees. The large apple orchard promises a good crop of fruit, and many varieties of pears, plums and cherries are also quite full, but the young trees will give but a light crop, although it is hoped that there will be enough in most cases to give an idea of the value of the fruit. The strawberry plants made a poor growth last year, and as a result only a light crop has been secured this spring, and the test of the varieties has not been satisfactory.

THE SOUTH HAVEN SUB-STATION.

Mr. S. H. Fulton has been in charge of the work at South Haven for the past year and has performed his duties in a very acceptable manner. The orchards and grounds have been well cared for, and his notes and reports have shown excellent judgment. During the last season many new varieties came into bearing and descriptions were given in the bulletin published during the winter. Although the crop of peaches was quite light, nearly all of the other fruits gave a good yield and brought good prices. The returns from the sweet cherries and English gooseberries were especially satisfactory, being about twice as much as was received for ordinary fruit, and the extra care taken in preparing it for market was well repaid.

During the summer, photographs of the orchards and of specimen trees of the different kinds of fruit were taken for exhibition at the Paris exposition. Copies of these photographs and forty plates of fruit of different kinds were also exhibited at the meeting of the American Pomological Society in Philadelphia last September and were awarded a Wilder silver medal.

Various experiments in spraying, pruning, thinning and fertilizing were tried during the year and the results were published in bulletin 176.

A large number of experiments in spraying for the leaf curl of the peach were tried in 1899, but as the disease was not very troublesome the results were not conclusive. Accordingly, the experiments were repeated in 1900, and the results fully substantiate the claims made in previous years.

The disease was quite troublesome in the vicinity of South Haven, and when the trees were not treated, those of varieties subject to attack lost nearly all of their leaves and much of their fruit. Profiting by the observations made in 1898 and previous years, nearly all of the trees were sprayed with copper sulphate solution (one pound in twenty-five gallons of water) during the first week in April, and these trees showed only here and there a curled leaf, the location of which indicated that the buds from which they came were not reached by the solution. A number of trees of the same varieties were not sprayed until the last week in April, and, although none of them were seriously injured, those that were of varieties subject to attack lost a good many leaves, while a single tree that was not sprayed at all dropped practically all of its foliage and fruit. The south row of trees in the southwest block gave an excellent illustration of the benefits of spraying. They are quite close to a hedge and it was difficult to reach them with the spraying material, especially as a strong breeze from the south was blowing at the time. As a result the south side of the trees was imperfectly sprayed and the foliage was much injured by leaf-curl, while upon the north side of the same trees little or no indication of the presence of the disease could be detected.

WORK AT THE UPPER PENINSULA STATION.

In order to test the adaptability of that portion of the State to the growing of the different kinds of large and small fruits, arrangements were made to test some of the most promising varieties at the Chatham sub-station. A list of varieties thought to be desirable for that section was prepared and submitted to Prof. Green of Minnesota, Prof. Goff of Wisconsin, Prof. Waugh of Vermont, Prof. Munson of Maine, Prof. Sears of Nova Scotia, and Prof. Craig of Iowa, but formerly of Ottawa, Canada, for criticism and suggestions. The lists secured in this way showed a remarkable similarity, and an endeavor was made to obtain as many as possible of the varieties. The trees were shipped to Chatham the last week in April, but were ten days in reaching there and arrived in poor condition. The tract selected for the orchard is a sandy loam and has a slight slope to the south, but at its north edge the land drops off abruptly for fifty feet. Owing to delay in clearing the land it could not be got ready for the trees before the first of June and they were planted out in nursery rows near the small fruits, which were planted on the other side of the ravine. The weather has been quite favorable and the loss has been smaller than was expected.

As the best results with small fruits in that section are likely to be secured from late varieties, and because the location is more favorable for holding the snow and a late start in the spring, the site chosen for them is on a north slope, where the soil is a light clay loam. The plantation includes about ten varieties each of strawberries, gooseberries, raspberries and currants; while the other orchard trees include about fifty varieties of apples, twenty each of plums and cherries, and

two each of pears and peaches. A few early varieties of grapes will also be tested. In the way of vegetables, small plantings were made of early and late cabbages, celery, beets, onions, turnips, sweet corn, potatoes and radishes.

During the year considerable time has been used in replying to letters upon matters relating to all lines of horticultural work, and a number of visits have been made to orchards in other sections of the State, when the subject was deemed of sufficient importance and when sufficient data to warrant a definite answer could not be secured by correspondence.

At the State Fair at Grand Rapids, in September, an exhibit of vegetables from the College and of fruits from South Haven was made.

L. R. TAFT,
Horticulturist.

AGRICULTURAL COLLEGE, MICH.,
June 23, 1900.

REPORT OF THE CHEMIST OF THE EXPERIMENT STATION.

Prof. C. D. Smith, Director of Experiment Station:

I herewith submit the report of the Chemical Department of the Experiment Station of the Agricultural College for the year closing June 30, 1900:

The laboratory of the Chemical Department has been a scene of busy activity for the entire year, the evidence of which appears in the test of analyses and investigations herewith submitted. To carry forward so many and so extended investigations in connection with lectures and class-room work of the College has taxed the powers of chemist and assistant alike.

WORK DONE DURING THE YEAR.

Cow Peas.—Analysis of three species of cow peas to determine the crude protein, total nitrogen, per cent of ash, of phosphoric acid and potash. This was done at the request of the Farm Department, to determine their use as fodder plants and their value as accumulators of fertilizing material.

Feeding Stuffs.—Analysis of six kinds of commercial feeding stuffs, to find their food value from their content of crude protein, fat and carbohydrates.

Samples from Association of Official Agricultural Chemists.—Consisting of wheat, of bran, and of clover seed, from Thorn Smith.

Pea Bran.—For complete analysis. Submitted by the Agricultural Department.

Fertilizers in the Market.—Nine samples of commercial fertilizers were analyzed in the fall of 1899, submitted for analysis after the fertilizer bulletin for the year had been printed.

Fertilizers in 1900.—Eighty-five specimens of commercial fertilizers

have been collected in the open market for the fertilizer bulletin for 1900.

Wood Ashes, and Crocker's Corn and Wheat Fertilizer.—Submitted by the Farm Department.

Lime Stone from Grand Rapids, submitted by the director.

SUGAR BEETS.

A large number of analyses of sugar beets have been made for numerous parties.

Sugar and Purity.—Five hundred and sixty-seven samples of beets have been analyzed during the year, to determine the percentage of sugar and the co-efficient of purity. Many of these analyses were made for the Farm Department in connection with experiments there carried on in the use of fertilizers, methods of cultivation, etc.

Pellet's Method.—Nine samples of sugar beets were analyzed by Pellet's method of extraction by hot water, to determine the per cent of sugar and the marc.

Entire Beet.—The whole beet, divided into three parts, leaves, neck and body, was analyzed separately, to determine the amount of sugar in each, the organic nitrogen and the ash elements, including potash, lime and phosphoric acid. This was done to find a basis for estimating the impoverishing influence of the removal from the field of one or more of these divisions of the beet.

For these analyses I am indebted to the help of my faithful assistant, L. H. Van Wormer.

PAPER ON SUGAR BEETS.

In connection with the work on sugar beets in the State, I attended the State meeting of the Farmers' Institutes in Ann Arbor and read a paper, "The Relation of Factory to Farm in the Beet Sugar Industry," and participated in the discussions on this subject.

THE MEETING IN SAN FRANCISCO.

Having been elected president of the Association of Official Agricultural Chemists, a body that has control of the official methods of analysis of fertilizers, food stuffs, etc., etc., in the United States, it became my duty to attend the meeting in July, 1899, at San Francisco, to preside at their meetings. The Association of Agricultural Colleges and Experiment Stations held a joint meeting at the same time and place, and I was thus enabled to attend the meetings of both bodies, and with Prof. Smith to represent the College and Station in these meetings.

The excursion, the meetings, and the opportunity to see so much of the agricultural and pomological resources of California, were very enjoyable, and especially to meet so many of our students holding high positions of trust and responsibility in the west.

FERTILIZER BULLETIN NO. 174.

The bulletin on fertilizers could not be issued till July, 1899, because of the difficulty of collecting in the open market the specimens for analysis on account of the tardiness of the shipment of these fertilizers into the State after May 1. While the bulletin cannot be issued in time for the spring trade, yet the information is available for use with the

farmers who sow it with the fall seeding. The large demand for copies of the bulletin by farmers and fruit growers shows that the efforts of the station to furnish full and reliable information on this subject are appreciated by our people.

A copy of Fertilizer Bulletin No. 174 is appended as part of this report.

Respectfully submitted,

R. C. KEDZIE,

Chemist of Experiment Station.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1900.

REPORT OF THE BACTERIOLOGIST AND HYGIENIST.

Director C. D. Smith:

The work in this department since last July has been primarily to close up work already outlined and under way. I have practically completed the work on tuberculosis, have carried a step farther the work on "Pure Milk Supply," and have collected the available data concerning the work with a gassy curd germ. What I have to say regarding these topics has been presented in the form of bulletins. During the year I have published a review of Bang's Work on Contagious Abortion. Although this matter has appeared in some periodicals, it seemed wise that stock-growers should be more acquainted with the facts of the case. In October of 1899 I concluded my experiments with "crown gall" on Mr. A. Hamilton's farm at Bangor. These experiments were for the purpose of establishing the infectiousness of the disease. The results were confirmatory. During the year Prof. Tuomey's researches were published, claiming to have found the cause of the gall, and inasmuch as I had not begun a systematic search for it, I have abandoned the work till a more opportune time, or it may be completely.

Besides the above systematic work, we have spent considerable time in examining specimens of different kinds sent to this laboratory. I have examined for different purposes during the past year fifty samples of water, twenty samples of milk, four samples suspected of actinomycosis, three specimens of suspected hog cholera or swine plague, three dogs for rabies, three specimens of pus, one specimen of suspected symptomatic anthrax, three specimens of cheese, three unknown specimens or suspected contagious diseases not well established, and I have tested three herds for tuberculosis, as well as examined ten specimens for tubercle bacilli. Such work as this requires no little time and attention.

It is my purpose to concentrate my efforts during the coming year and not to attempt to cover such a wide field.

In closing this report, I desire to express my appreciation of the faithful assistance of Mr. S. F. Edwards.

Very respectfully submitted,

CHARLES E. MARSHALL.

Department of Bacteriology and Hygiene.

June 21, 1900.

REPORT OF THE CONSULTING BOTANIST.

Prof. C. D. Smith, Director of Experiment Station:

DEAR SIR—There has been no change in the duties of the consulting botanist from former years, except a considerable increase in the amount of work done. This fact must be taken into account when but one-half of the time of the consulting botanist is expected to be devoted to station work, and when in fact over three-fourths of his time has of necessity been devoted to College work during the year past.

The work may be included under the following heads, viz.: Seed testing, plant diseases, naming plants, work in the herbarium.

SEED TESTING.

During the past year the number of samples of clover and grass seeds submitted for examination has largely increased, and the results show that Michigan grown clover seed is quite free from impurities and of good vitality. One interesting fact has been brought out, viz., that two-year-old clover seed has given a higher per cent of vitality than one-year-old seed.

The necessity for the examination of clover seed before purchasing is plainly to be seen when some of the cheaper samples of seed that are offered in our markets are tested. These show a considerable amount of weed seeds, dirt, and a low percentage of vitality.

During the year many samples of beet seed have been tested for the Experiment Station of this College, for the Detroit Sugar Co. and for the Alma Sugar Co.

The Detroit Sugar Co. made its entire purchase of seeds from the results of the above tests.

PLANT DISEASES.

The clover disease mentioned in the report for 1897, p. 99, Gleosporium trifolii, has continued to infest the clover fields of the station and the farm. It has been observed that the clover plants which are troubled with the root borer suffer the most from this disease. No means of cure are yet known, although in a well arranged rotation this disease is little to be found.

An apple tree disease new to science has appeared in Michigan during the year. Some diseased limbs of Baldwins were sent to the station botanist. The diseased specimens were taken from nursery stock which Mr. J. B. McCallum of Holton had purchased from Hoopes Bros. & Thomas, Pennsylvania. Diseased specimens were sent to J. B. Ellis, who kindly named and described the disease.

ASCOCHYTA MALI E. & E.

The following description may help in the detection of this disease:

"Spots circular, ½ to 1 Cm. in diameter, concave, of a pale brick-red color, with margin narrowly free, sometimes becoming much larger, extending for two centimeters or nearly surrounding the limb. These

spots appear to be formed from the altered substance of the bark, which is changed in color and cracks away around the margin from the surrounding bark, which remains in its normal condition; perithecia at first solitary, finally two to four or more scattered on the same disk; sporous oblong or oblong elliptical, smoky hyoline, uniseptate, 6 to 8 by 2½ to 3½ m. The fungus soon kills the limbs.

ASPARAGUS RUST.

This disease was first reported in Michigan, August 18, 1898, by Mr. L. W. Ruth, of Benton Harbor, Mich.

Mr. Ruth was advised to cut the canes and when dry to burn the field, hoping thereby to destroy a large number of the winter spores which had fallen to the ground. This was done, but the disease was not checked to any appreciable extent.

During the fall of 1899 Mr. Paul Thayer, at my suggestion, collected some facts, showing a great increase in the spread of the rust about Benton Harbor during 1899. The disease seems to be worse on the light dry soils. Mr. Thayer found the disease present on seventeen plantations which aggregated sixty-six and one-half acres.

The only treatments given were by Mr. Ewald, who sprayed with Bordeaux, and Mr. Ruth, who cut and burned the canes, with no good results in either case.

Whether any preventive measures can be used, beyond proper manuring and cultivation, remains to be found out by future experiments.

NAMING PLANTS.

Hundreds of plants have been sent for names during the year. Among these may be specially mentioned a bundle of over two hundred sedges sent by the Division of Agrostology of the U. S. Department of Agriculture, Washington, D. C.; one hundred and forty-five plants collected by Prof. U. P. Hedrick, near Logan, Utah.

Many teachers, as well as farmers and fruit growers, send plants and weeds to be named. Several persons in other parts of the State have sent well preserved specimens of the plants of their localities, which have been named and turned into the general herbarium to the advantage of all.

A large proportion of the plants received are weeds, sent mainly by farmers and fruit growers.

HERBARIUM WORK.

Work in the College herbarium requires a good deal of time during the whole of the year. Unfortunately, the station, as such, possesses no separate herbarium, and there can be no distinction between College and station work here.

C. F. WHEELER,
Consulting Botanist.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1900.

REPORT OF CONSULTING ENTOMOLOGIST.

Prof. C. D. Smith, Director:

DEAR SIR—Following is a brief account of the work done by the Entomological Department of the Experiment Station during the year ending June 30, 1900:

On September 1, 1899, the writer was made consulting entomologist of the Experiment Station on the resignation of Prof. Barrows from that position. Previous to that time the writer had held the position of assistant entomologist.

The season of 1899 was quite a departure from the average as regards climate, and this has produced a corresponding change in the insect life. The hot, dry weather in midsummer favored certain insects, notably flea-beetles, at the same time restraining others. The exceptionally late fall favored the Hessian fly, and at the present time this pest is present in numbers in certain parts of the State.

During the year two bulletins have been published by this office, numbers 175 and 180. The work of the year has been quite diversified; the correspondence being, at times, quite an item. A number of trips have been made to investigate insect problems and to try remedies in the field, one to South Haven and vicinity to investigate various fruit insects; one to Benton Harbor to investigate insects working on peach buds; one to Three Rivers to investigate insects working on sugar beet; besides several shorter trips made for like purposes.

The work against sugar beet insects has been carried on as diligently as possible, believing that this important crop, new to the State, should be well guarded, and methods of protecting it understood. A number of insects affecting this crop have given trouble during the season, notably two flea-beetles and the garden web-worm, as well as several blister-beetles.

The strawberry root borer appeared in numbers in the southern part of the State, also the raspberry saw-fly.

A new scale insect of prime importance from an economic standpoint has been discovered in the United States during the year and Michigan has been found to possess her share of them. A study of this pest has been made and information, which could be used by him, turned over to the State Inspector of Orchards and Nurseries, both in regard to the habits and work of the scale as well as the infested localities discovered.

The canker worm has made its presence very evident both during the season of 1899 and 1900 in many parts of the State, and a nearly related species, the lime tree inch worm (Hibernia tiliaria) has appeared in several places and is rivaling the ordinary canker worm in its depredations. It may be controlled by the same methods as are found effective against the canker worm.

Whenever possible, specimens and information regarding scale insects have been collected, with a view to writing an extended bulletin on the subject in the future.

At the present time the writer is working on several pests, one of which is boring in the box elder and several other trees; another is a

feeder on strawberry leaves and still another is the well-known peach borer.

Numerous articles on insects and their control have been written for the newspapers and agricultural periodicals, at times when information was especially desirable regarding specific insects.

Meetings of the Association of Economic Entomologists of America, and of the American Association for the Advancement of Science, at Columbus, Ohio, were attended at the writer's expense.

The rearing of insects under investigation, and the consequent finding of weak points in their life history when they may be fought to advantage, is carried on under great difficulties; most of the insects dying because of the lack of a suitable room to keep them in. A small glass building, such as is used for greenhouse purposes, where the temperature, moisture, etc., can be regulated, and where an approach to outside conditions may be obtained, has been found useful in several other States and could be used to great advantage here.

It remains for the writer to express his sincere appreciation and thanks for the kind aid of Professor Barrows in the form of advice and information, both of which are always to be had for the asking, and for many courtesies extended at all times.

Respectfully submitted,

R. H. PETTIT,

Consulting Entomologist.

AGRICULTURAL COLLEGE, MICH.,

June 30, 1900.

REPORT OF CONSULTING VETERINARIAN.

Director C. D. Smith:

SIR—As consulting veterinarian for the Experiment Station I have the honor to present the following report:

The greater part of my work in this connection has been in replying to letters received relative to the diseases of live stock. It is very gratifying to report that, so far as my knowledge goes, no serious outbreak of any contagious disorder has visited the live stock of the State during the past year. The outbreaks of certain contagious swine disorders, which visited the State two years ago, have evidently to a very great extent died out, inasmuch as no letters have been received relative to these conditions during the year just past.

The sheep industry of the State is threatened with a menace in the form of certain internal parasitic diseases; among these the strongylus contortus, or stomach worm, and the oesophagostoma columbianum, which produces the so-called nodular disease, are doing the most harm. The stomach worm does the most harm among lambs; the lambs may not show any evidences of the parasite in the fall when they are being picked up for feeding purposes, but will develop the disease during the

winter to such an extent as to produce a great loss. In one flock of a thousand lambs, which had been fed during the winter, which was visited this spring, ten per cent were so badly affected with the parasite that at the end of the winter's feeding they were poorer, and would bring less in the market than when bought last fall, and yet they had consumed as much feed as others in the same pens which were in prime condition. Other feeders of the State experienced the same loss, only not to the same extent. Some of the feeders are discriminating against Michigan lambs on account of these internal parasites. Inasmuch as these disorders are taking on such grave proportions, I would respectfully recommend that as soon as possible a series of experiments be started with the view of discovering some practical remedy, which will act as a preventive, in ridding the animal of the parasites before they have accumulated in sufficient numbers to cause harm.

Another condition which seems to be a menace to the stock interests of the State is the disregard the average stock owner has in reference to the spread of contagious diseases. This was plainly exemplified two years ago in the case of the swine disorders. In most cases no precautions at all were taken to prevent the spread of the disease, neighboring stockmen visited the affected drove freely, the sick animals were allowed to roam over the entire farm, or a large portion of it, and in some cases the dead animals were left lying where they died, thus forming a center for the spread of the disease throughout the entire community. This condition may be due in part to carelessness, to indifference, but it would seem as though it must be very largely due to ignorance on the part of the average farmer; and if some systematic and practical method of education could be inaugurated along this line we believe that the stock interests of the State would receive an insurance against the spread of contagious disorders of all kinds, which would in time prove to be of great value.

Very respectfully submitted,

GEO. A. WATERMAN.

AGRICULTURAL COLLEGE, MICH.,
June 23, 1900.

REPORT OF THE APIARIST.

Prof. C. D. Smith:

SIR—During the year much attention has been given to the treatment of foul brood in infected apiaries in different parts of the State. After experimenting on different methods of treating the diseased colonies, including sulphur and acids, none were found to be effective except the starvation treatment. If this is carefully carried out the results will be satisfactory in every case. I have visited many apiaries in eastern and central Michigan and have, in many cases, assisted the owners in treating their diseased colonies. I have observed while on these trips that foul brood is fast ruining some of our best apiaries in the most favorable localities for honey production in the State. The only way to control the disease is to educate the apiarists to readily recognize and knowingly treat the disease. (This can only be done by means of a State inspector, which, at present, the State laws do not provide for.) Other diseases of brood have been noticed in various parts of the State, which should be investigated. This will be a part of the work for the coming year.

The continued experiment on lengthening the tongues of the bees so that it will be possible for them to reach the nectar in such flowers as June clover, has been carried on with little success, the average length of the tongues of those colonies under experiment being no longer than a year ago, the principal difficulty seeming to be the failure of the desirable mating of the queens. When this difficulty can be overcome, it may be possible to breed up a strain of bees superior to anything now known.

On August 1 the bees were moved three miles north of the College to the center of the Chandler marsh. The golden rod, boneset and asters were plentiful, and it was expected that the bees would store much more nectar than if they were obliged to fly this distance to the flora. On account of the continued drouth there was little nectar to be secured. The results were as was expected. Those left in the home yard lost much more in weight than those taken to the marsh. This is the second experiment that has been worked out along this line with similar results (Mich. Board Report, 1898, p. 141). The proof seems to be conclusive that bees can store more honey when taken to the flora than when compelled to fly a distance to secure the nectar.

An experiment was made to test the value of double starters, a narrow one in the bottom and a wide one in the top of the section. The single starters were full shuts. In every case the best looking combs were built on the double starters. At the close of the honey flow, the sections having double starters, even though not full, the combs were securely attached to all four sides of the section, while those sections having full shuts the comb was suspended from the top, making it impossible to shift them, while the double starter sections would shift with perfect safety.

There is in the apiary about an equal number of eight and ten frame

hives sitting side by side, which we have been watching during the past season. The colonies in the small hives were observed to store the most honey in the surplus cases in a short flow, but the colonies in large hives wintered the best in every case.

A trial was made with Michigan beet sugar, compared with cane sugar, as a winter and spring feed. The beet sugar was found to be equal in every respect to the cane. The bees took the feed readily and no bad results of any kind were seen.

Different methods of outdoor wintering were tried with as greatly different results. The bees were all either chaff packed or in chaff hives, with the exception of two colonies. These two were strong in the fall, but the only protection given them was a chaff cushion over the frames. These two colonies both died of spring dwindling. The best method of wintering was found to be that of giving plenty of upward ventilation in chaff inside a tight wintering case. The dovetailed chaff hive, with a cushion over the frames and a telescoped cover, also gave good results.

Respectfully submitted,

J. M. RANKIN,

Apiarist.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1900.

SUMMARY OF THE METEOROLOGICAL OBSERVATIONS AT THE M. A. C. FOR 1899.

Months.	Mean daily temperature in open air.	Percentage of humidity, saturation—100.	Pressure of vapor of water in air.	Height of barometer reduced to temperature of 32° F.	Percentage of cloudiness.	Self-registering thermometer. Maximum.	Self-registering thermometer. Minimum.	Amount of rain or melted snow in inches.	Snow in inches.	Number of thunder storms.
January	21.80	99.4	.133	29.199	51.0	29.4	14.1	2.16	4.00	0
February	16.20	98.9	.119	28.862	48.0	26.3	7.0	1.51	2.80	0
March	27.32	97.4	.151	28.937	69.0	34.2	18.8	3.88	25.75	0
April	51.40	82.8	.351	29.095	42.0	61.2	38.4	1.56	0	0
May	59.77	86.2	.458	29.096	49.0	70.5	47.1	3.59	0	0
June	70.29	83.6	.628	29.123	27.0	80.4	55.7	1.15	0	5
July	70.70	87.5	.669	29.065	46.9	81.0	55.5	2.11	0	0
August	76.56	79.0	.636	29.080	29.4	89.0	56.0	.70	0	0
September	58.60	85.9	.457	29.151	53.5	68.5	44.9	2.14	0	0
October	54.10	86.3	.447	29.237	38.7	64.7	41.7	2.68	0	0
November	40.04	88.7	.233	29.147	62.0	47.5	31.8	1.72	3.00	0
December	26.49	93.1	.149	29.059	58.2	31.7	18.6	1.53	3.60	0
Year	47.76	89.1	.369	29.088	47.9	57.0	35.8	24.73	39.15	5

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.				Relative humidity, or per cent of saturation.			Pressure of vapor, in inches.			Barometer reduced to freezing point.			
	7 A. M.	2 P. M.	9 P. M.	Daily mean.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Mean.
S 1......	11	19	11	13⅔	100	100	100	.071	.103	.071	29.800	29.746	29.690	29.745
M 2......	16	32	20	22⅔	100	100	100	.090	.181	.108	29.654	29.529	29.403	29.529
T 3......	25	40	41	35⅓	100	100	91	.135	.248	.235	29.333	29.229	29.105	29.222
W 4......	44	47	28	39⅔	100	100	100	.289	.323	.153	29.019	28.857	29.015	28.964
T 5......	15	18	18	17	100	100	100	.086	.098	.098	29.379	29.415	29.473	29.432
F 6......	20	23	15	19⅓	100	100	100	.108	.123	.086	29.187	28.952	29.067	29.069
S 7......	13	11	8	10⅔	100	100	100	.078	.071	.062	29.119	29.258	29.389	29.255
S 8......	24	35	20	26⅓	100	90	100	.129	.183	.108	29.179	29.178	29.369	29.242
M 9......	13	17	12	14	100	100	100	.078	.094	.075	29.405	29.478	29.586	29.490
T 10......	7	20	11	12⅔	100	100	100	.060	.108	.071	29.656	29.702	29.752	29.703
W 11......	5	20	16	13⅔	100	100	100	.055	.108	.090	29.714	29.603	29.481	29.599
T 12......	22	34	35	30⅓	100	100	100	.118	.196	.204	29.382	29.265	29.186	29.278
F 13......	37	38	38	37⅔	100	100	100	.221	.229	.229	29.119	29.111	28.991	29.074
S 14......	34	35	36	35	100	100	100	.196	.204	.212	28.826	28.977	29.061	28.955
S 15......	32	42	38	37⅓	100	91	91	.181	.244	.186	29.155	29.131	29.039	29.108
M 16......	33	39	32	34⅔	100	91	100	.188	.216	.181	28.945	28.911	29.031	28.962
T 17......	30	31	23	28	100	100	100	.167	.174	.123	29.139	29.218	29.409	29.255
W 18......	11	23	14	16	100	100	100	.071	.123	.082	29.557	29.511	29.534	29.534
T 19......	13	30	23	22	100	100	100	.078	.167	.123	29.537	29.378	29.309	29.408
F 20......	27	32	29	29⅓	100	100	100	.147	.181	.160	29.237	29.131	28,905	29.091
S 21......	34	35	32	33⅔	100	100	100	.196	.204	.186	28.747	28.805	28.869	28.807
S 22......	30	34	34	32⅔	100	100	96	.167	.196	.196	29.017	29.097	29.135	29.083
M 23......	28	43	32	34⅓	100	92	100	.153	.254	.186	29.046	28.982	28.885	28.971
T 24......	25	28	21	24⅔	100	100	100	.135	.153	.113	28.930	28.929	28.997	28.952
W 25......	21	31	35	29⅓	100	100	100	.113	.174	.204	29.044	29.019	28.765	28.943
T 26......	35	21	10	22	100	100	100	.204	.113	.068	28.619	28.609	28.952	28.727
F 27......	4	14	5	7⅔	100	100	100	.052	.082	.055	29.269	29.223	29.052	29.181
S 28......	10	9	—5	4⅔	100	100	100	.068	.065	.035	28.972	29.045	29.150	29.056
S 29......	—4	3	—1	—⅔	100	100	100	.036	.050	.042	29.196	29.091	29.045	29.077
M 30......	4	1	—9	—1⅓	100	100	100	.052	.046	.029	28.960	29.198	29.289	29.149
T 31......	—14	4	—5	—5	100	100	100	.024	.052	.035	29.319	29.253	29.345	29.306
Sums......	......	......	......	......	......	......	......	......	......	......	....	....	....	....
Means......	......	......	......	21.8	100	98.8	99.3	.121	.154	.123	....	....	....	29.199
Average......	......	......	......	......		99.4			.133		....	....	....	....

JANUARY, 1899, AT AGRICULTURAL COLLEGE, LANSING, MICHIGAN.

Clouds.						Winds.						Registering thermom'r.		Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
70	Cu.	95	Cu.	10	Cu.	n e	4	s	5	s	6	39	10				
80	Cu.	100	Cu.	20	Cu.	s w	8	s w	14	s w	5	32	20				
		100	Cu.	100	Nim.	s w	7	s w	11	s	15	44	16	5 p. m.			
100	Nim.	100	Nim.	20	Cir.	s	11	s		n w		48	28		6 p. m.	1.10	
30	Cir.	88	Cu.	100	Cu.	n w		n w		w		20	14				
100	Nim.	100	Nim.	100	Nim.	s e		s w		w		23	15	*			
100	Nim.	80	Cu.			n w		n w		n w	9	24	6		12 m.	.25	2½
40	Cu. St.	60	Cu.			w	11	w	17	w	3	35	3				
100	Cu.	80	Cu.			n	3	n	3	n	2	18	11				
						n e	1	n e	6	n e	4	20	5				
						e	7	e	6	e	6	22	5				
100	Cu.	100	Cu.	100	Cu.	s	7	s	8	s	9	37	16				
100	Cu.	100	Cu.	100	Nim.	s	2	s	2	s	4	40	36		In night.	.65	
100	Nim.	80	Cu.			n w	6	n w	11	n w	7	37	32				
				60	Cir.	s w	5	s w	8	s w	7	42	30				
60	Cir.	100	Cu.	80	Cu.	s w	5	s	3	s w	2	40	29				
60	Cir.Cu.	100	Cu.			n w	2	n w	4	n w	3	31	23				
						n w	2	n w	2	w	7	23	11				
				60	Cu.	s w	4	w	14	s w	13	31	12				
100	Cu.	100	Cu.			s w	12	s w	12	s w	16	35	22				
100	Cu.	60	Cu.	40	Cir.	n	19	n w	16	n w	4	36	29				
60	Cu.	60	Cu.	40	Cir.	n w	3	s w	5	s w	6	35	22				
50	Cir.	50	Cu.	100	Cu.	s w	12	s	9	n w	3	45	26	†		.03	.25
60	Cir.Cu.			60	Cir.	n w	3	n w	7	n w	1	30	21				
80	Cu.			100	Cu.	s w	6	s	8	s	19	37	16				
100	Nim.	100	Nim.	60	Cu.	s w	16	n w	21	n w	9	35	10	‡		.10	1
		100	Cu.			n w	5	n w	13	w	14	15	4				
		100	Cu.			s	15	n	10	n	2	16	—5				
						s w	3	s w	14	s w	12	11	—8				
100	Nim.	20	Cu.			w	10	n w	9	n w		5	—9	§	11 a. m.	.03	.25
						s w		w	3	w	2	5	—14				
																2.16	4.00
55		60		37								29.4	14.1				
		51.															

* Snow 7 a. m. † Snow in night. ‡ Snow during day. § Snow 5 a. m.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air. 7 A. M.	2 P. M.	9 P. M.	Daily mean.	Relative humidity, or per cent of saturation. 7 A. M.	2 P. M.	9 P. M.	Pressure of vapor, in inches. 7 A. M.	2 P. M.	9 P. M.	Barometer reduced to freezing point. 7 A. M.	2 P. M.	9 P. M.	Mean.
W 1...	0	15	7	7⅓	100	100	100	.044	.086	.060	29.373	29.289	29.219	29.294
T 2.....	15	22	11	16	100	100	100	.086	.118	.071	29.317	29.269	29.269	29.285
F 3.....	18	22	15	18⅓	100	100	100	.098	.118	.086	29.089	29.045	29.091	29.075
S 4.....	4	20	10	11⅓	100	100	100	.052	.108	.068	29.201	29.221	29.284	29.235
S 5.....	3	12	—1	4⅔	100	100	100	050	.075	.042	29.209	29.131	29.139	29.160
M 6.....	—10	12	—1	0⅓	100	100	100	.028	.075	.042	29.061	28.951	28.891	28.968
T 7.....	—9	8	4	1	100	100	100	.029	.062	.052	28.890	28.791	28.691	28.791
W 8.....	—11	6	—5	—3⅓	100	100	100	.027	.057	.035	28.580	28.605	28.685	28.623
T 9.....	—10	—3	—15	—9⅓	100	100	100	.028	.038	.023	28.819	28.897	29.085	28.934
F 10.....	—21	—2	—18	—13⅔	100	100	100	.017	.040	.020	29.161	29.203	29.359	29.241
S 11.....	—22	—3	—18	—14⅓	100	100	100	.017	.038	.020	29.404	29.337	29.372	29.371
S 12.....	—24	—2	—17	—14⅓	100	100	100	.015	.040	.021	29.375	29.225	29.182	29.261
M 13.....	—20	4	—2	—6	100	100	100	.018	.052	.040	29.089	28.969	28.935	28.998
T 14.....	—2	21	16	11⅔	100	100	100	.040	.113	.090	28.972	28.921	28.931	28.941
W 15.....	23	32	26	27	100	100	100	.123	.181	.141	28.935	28.911	28.911	28.919
T 16.....	20	43	32	31⅔	100	100	100	.108	.278	.181	28.862	28.784	28.783	28.810
F 17.....	32	46	32	36⅔	100	100	100	.181	.311	.181	28.720	28.697	28.591	28.669
S 18.....	34	37	28	33	100	100	100	.196	.221	.153	28.557	28.521	28.501	28.526
S 19.....	31	48	37	38⅔	100	92	100	.174	.310	.221	28.505	28.384	28.394	28.428
M 20.....	38	48	37	41	100	85	100	.229	.285	.221	28.301	28.314	28.396	28.337
T 21.....	30	45	33	36	100	76	100	.167	.228	.188	28.407	28.335	28.290	28.344
W 22.....	33	45	31	36⅓	100	100	100	.188	.300	.174	28.416	28.493	28.596	28.502
T 23.....	24	24	21	23	100	100	100	.129	.129	.113	28.660	28.891	28.997	28.849
F 24.....	16	26	13	18⅓	100	100	100	.090	.141	.078	29.052	29.083	29.091	29.675
S 25.....	21	31	33	28⅓	100	100	100	.113	.174	.188	29.055	28.937	28.641	28.878
S 26.....	44	55	31	43⅓	100	87	100	.289	.376	.174	28.387	28.343	28.457	28.396
M 27....	21	20	21	20⅔	100	100	100	.113	.108	.113	28.670	28.769	28.699	28.713
T 28.....	36	34	18	29⅓	80	100	100	.170	.196	.098	28.470	28.420	28.655	28.515
Sums.....														
Means ...				16.2	99.3	97.5	100	.161	.152	.103				28.862
Average..						98.9			.119					

FEBRUARY, 1899, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Registering thermom'r.		Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
40	Cir.	80	Cu.			s w	6	s w	8		0	16	—7				
100	Cu.	100	Cu.			e	1	e	2	e	2	22	5		*	.05	.3
100	Cu.	100	Cu.			e	1		0	e	4	23	10				
		80	Cu.			w	1	s w	7	s w	1	23	4				
						s w	2	s w	3		0	12	—1				
							0	s w	4	s w	2	15	—10				
						s w	1	s w	4	s w	2	12	—11				
		80	Cu.	100	Cu.	s w	1	s w	13	w	8	7	—12				
20	Cu.	20	Cu.			n w	7	n w	15		0	—2	—15				
						n w	1	n w	6	w	1	—1	—21				
							0	n w	3		0	—1	—22				
						w	1	s w	3	s w	1	—1	—24				
						s w	1	s w	3	s w	1	7	—20				
20	Cir.	40	Cir.	100	Nim.	s w	3	s w	9	s w	12	23	—7	†6 p.m.	8 p. m.	**	
100	Cu.	90	Cu.			s w	10	s w	10	s w	4	35	16				
20	Cir.	10	Cir.			s w	4	s w	6	s w	8	44	19				
80	Cir.Cu.	60	Cir.Cu.	100	Cu.	s w	7	s w	8	s w	9	48	28				
100	Cu.	80	Cu.	100	Nim.	s w	7	s w	10	s w	9	38	28	†6 P. M.	8 P. M.	.10	1.0
80	Cir.Cu.	80	Cu.	100	Nim.	w	7	s w	21	s w	10	48	27	‡		**	
		20	Cir.	80	Cu.	s	6	s w	13	s w	1	48	35				
80	Cir.Cu.	100	Cu.	100	Nim.		0		0	e	3	45	29	§		.07	
100	Cu.	100	Nim.	100	Nim.	s w	1		0		0	45	31	‖		.35	$1\frac{1}{2}$
100	Cu.	100	Cu.	100	Cu.	n w	2	n	3	n	1	24	21				
40	Cir.Cu.					n w	3	n w	2	s e	6	30	7				
100	Cu.	100	Cu.	100	Nim.	s e	7	s e	11	s e	24	44	17	§		.79	
100	Cu.	100	Nim.	100	Nim.	s e	8	s w	11	n w	17	55	31	1:30 pm	2:30 pm	.08	
40	Cu.	60	Cu.	50	Cu.	n w	14	n w	17	n w	17	36	20	¶11am		.08	
100	Cu.	100	Nim.	80	Cu.	s w	16	s w	16	n w	5	41	18			.07	
																1.51	2.8
47		53		43								26.3	7.00				
48																	

* Snow in night. † Snow. ‡ Rain evening. § Rain in night. ‖ Rain and snow during day. ¶ Snow and rain. ** Trace.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.				Relative humidity, or per cent of saturation.			Pressure of vapor, in inches.			Barometer reduced to freezing point.			
	7 A. M.	2 P. M.	9 P. M.	Daily mean.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Mean.
W 1......	17	30	30	25⅔	100	100	89	.094	.167	.148	28.712	28.678	28.598	28.663
T 2......	29	42	35	35⅓	88	74	100	.142	.199	.204	28.620	28.612	28.634	28.622
F 3......	35	37	34	35⅓	100	100	100	.204	.222	.196	28.655	28.648	28.691	28.665
S 4......	27	31	25	27⅔	100	89	100	.147	.155	.135	28.777	28.713	28.407	28.632
S 5......	24	32	22	26	100	100	100	.129	.181	.118	28.331	28.566	28.640	28.512
M 6......	15	19	10	14⅔	100	100	100	.086	.103	.068	28.699	28.686	29.179	28.855
T 7......	11	22	8	13⅔	100	100	100	.071	.118	.062	29.309	29.355	29.419	29.361
W 8......	11	26	20	19	100	100	100	.071	.141	.108	29.429	29.325	29.149	29.301
T 9......	30	37	33	33⅓	100	81	100	.167	.178	.188	29.063	29.084	29.169	29.105
F 10......	31	36	38	35	100	90	100	.174	.191	.229	29.160	29.169	28.957	29.095
S 11......	47	60	51	52⅔	92	82	93	.298	.426	.348	28.905	28.721	28.591	28.739
S 12......	32	21	24	29	100	100	100	.181	.174	.129	28.592	28.764	29.047	28.801
M 13	21	24	22	22⅓	100	100	100	.113	.129	.118	29.289	29.380	29.409	29.359
T 14......	24	28	31	27⅔	100	100	89	.129	.153	.155	29.406	29.295	28.991	29.231
W 15......	40	39	30	36⅓	91	91	100	.225	.216	.167	28.613	28.613	29.127	28.784
T 16......	22	31	26	26⅓	100	89	100	.118	.155	.141	29.311	29.407	29.289	29.336
F 17......	24	33	33	30	100	89	100	.129	.168	.188	29.253	29.153	28.919	29.108
S 18......	32	29	21	27⅓	100	100	100	.181	.160	.113	28.618	28.637	28.628	28.628
S 19	20	31	22	24⅓	100	100	100	.108	.174	.118	28.705	28.791	28.977	28.824
M 20.....	13	19	17	16⅓	100	100	100	.078	.103	.094	29.197	29.250	29.245	29.231
T 21......	19	26	34	26⅓	100	100	100	.103	.141	.196	29.080	28.902	28.717	28.900
W 22......	37	36	24	32⅓	90	100	100	.199	.212	.129	28.729	28.743	28.832	28.768
T 23......	20	16	28	21⅓	100	100	100	.108	.153	.090	29.032	29.041	29.147	29.073
F 24......	16	30	25	23⅔	100	100	100	.090	.167	.135	29.173	29.169	28.997	29.113
S 25......	28	35	26	29⅔	100	90	100	.153	.183	.141	28.700	28.518	28.697	28.658
S 26......	22	35	22	26⅓	100	90	100	.118	.183	.118	29.101	29.127	29.172	29.133
M 27......	24	40	28	30⅔	100	82	100	.129	.203	.153	29.217	29.196	29.051	29.155
T 28......	28	30	24	27⅓	100	100	100	.153	.167	.129	28.863	28.691	28.702	28.752
W 29......	18	26	14	19⅓	100	100	100	.098	.141	.082	28.744	28.752	28.897	28.798
T 30......	21	30	26	25⅔	100	100	100	.113	.167	.141	28.934	28.899	28.860	28.898
F 31......	20	31	28	26⅓	100	78	100	.108	.136	.153	28.905	28.934	29.006	28.948
Sums.....	......	......	......	......	......	......	......	......	......	......	....	....	....	....
Means....	......	.....	......	27.32	98.7	94.4	99.1	.136	.173	.145	....	....	....	28.937
Average..	......	......	......	......		97.4			.151		....	....	....	....

MARCH, 1899, AT AGRICULTURAL COLLEGE, LANSING, MICHIGAN.

Clouds.						Winds.						Registering thermom'r.		Rain and snow.			
7. A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
40	Cir.Str.	60	Cir.	....	....	w	3	s w	2	s w	2	32	14	....	....	......	......
100	Cu.	85	Cu.	....	....	s w	3	s e	2	s e	1	42	27	....	....	......	......
100	Cu.	100	Nim.	100	Nim.	s e	1	n e	3	n e	4	37	33	9 a. m.	7 p. m.	.38	......
80	Cu.	100	Cu.	100	Nim.	n w	5	n e	7	n e	13	31	24	*6 p. m.	....	......	......
80	Cu.	20	Cu.	....	....	n	13	n w	17	n w	5	32	22	....	8 a. m.	.70	7.
100	Nim.	60	Cir.Cu.	....	....	n w	5	n w	6	n	8	20	10	*7 a. m.	†	.03	.25
50	Cu.	....	....	....	....	n	5	....	0	n w	1	24	7	....	....	......	......
100	Cu.	50	Cu.	100	Cu.	s w	7	s w	10	....	0	30	5	....	....	......	......
100	Cu.	100	Cu.	100	Cu.	s w	5	s w	8	s e	3	38	18	....	....	......	......
100	Cu.	100	Cu.	100	Cu.	s e	8	s	13	s	7	47	31	‡10 a.m.	11 a. m.	.02	......
80	Cu.	31	Cu.	100	Nim.	s	12	s w	10	s w	23	61	31	‡9 p. m.	†	.02	......
100	Nim.	100	Nim.	100	Cu.	s w	21	s w	18	n	4	32	24	*7 a. m.	11 a. m.	.10	1.
100	Cu.	100	Cu.	100	Cu.	w	4	n w	4	n	2	24	21	....	....	......	......
100	Cu.	100	Cu.	100	Cu.	n e	7	e	9	e	10	40	21	†Rain.	....	.05	......
100	Cu.	100	Cu.	100	Cu.	s e	8	n w	18	n e	6	48	21	§Rain.	....	‖	......
10	Cir.Str.	10	Cu.	100	Nim.	s e	4	s e	2	s e	5	32	21	†Snow.	....	.05	.5
100	Nim.	100	Nim.	100	Nim.	s	6	s	9	s	4	33	21	¶9 p. m.	†	.88	1.
100	Nim.	100	Cu.	100	Cu.	s w	5	n e	....	n e	....	32	20	....	....	......	......
100	Cu.	40	Cir.	100	Nim.	n	....	n	....	n w	....	31	19	**	....	‖	......
20	Cu.	....	....	20	Cir.	n w	....	n w	7	n e	7	21	13	††	....	......	......
100	Nim.	100	Nim.	100	Cu.	s e	11	s e	11	s e	5	34	16	‡2 p. m.	2 p. m.	.80	8.
100	Cu.	100	Nim.	100	Cu.	s	5	n	3	n	9	39	24	‡‡12 M.	6 p. m.	.05, .4	4.
30	Cir.Cu.	20	Cu.	....	....	n w	7	n w	13	....	0	28	16	....	....	......	......
....	....	....	....	100	Cu.	s w	2	s w	10	s w	7	33	8	§§	....	......	......
100	Nim.	100	Cu.	100	Cu.	s e	10	n w	8	n w	4	36	19	....	8 a. m.	.25	2½.
....	....	....	....	20	Cir.	n w	5	....	0	s w	4	35	18	....	....	......	......
80	Cu.	80	Cir.Cu.	100	Cu.	s e	2	s w	3	s e	1	42	16	†Snow.	....	......	......
100	Nim.	100	Nim.	....	....	n e	1	n e	8	n e	2	30	24	....	5 p. m.	.10	1.
60	Cir.Cu.	80	Cu.	....	....	n w	11	w	16	....	0	30	14	‖‖Snow	....	.05	.5
20	Cir.	100	Cu.	....	....	w	1	s	2	s e	1	33	8	....	....	......	......
50	Cir.	60	Cir.Cu.	100	Nim.	n	8	w	11	w	5	33	18	¶¶ Snow	....	......	......
2300	....	2095	....	2040	....	....	....	....	....	....	....	......	......	....	....	3.88	25.75
74	....	68	....	66	....	....	....	....	....	....	....	34.2	18.8	....	....	......	......
69						....	....	....	....	....	....	......	......	....	....	......	......

*Snow. † In night. ‡ Rain. § Rain during day. ‖ Trace.
¶ Snow continued, turned to rain at ** Snow flurries in night. †† Snow in night continued.
‡‡ Snow in night. §§ Snow midnight. ‖‖ Snow flurries. ¶¶ Snow flurry.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of Month.	Thermometer, in open air. 7 A. M.	2 P. M.	9 P. M.	Daily mean.	Relative humidity, or per cent of saturation. 7 A. M.	2 P. M.	9 P. M.	Pressure of vapor, in inches. 7 A. M.	2 P. M.	9 P. M.	Barometer reduced to freezing point. 7 A. M.	2 P. M.	9 P. M.	Mean.
S 1......	25	28	25	26	87	76	87	.117	.117	.117	29.036	29.065	29.158	29.086
S 2......	24	28	29	27	73	76	77	.094	.117	.123	29.195	29.247	29.275	29.239
M 3......	25	38	24	29	74	72	100	.100	.165	.129	29.364	29.351	29.375	29.363
T 4......	24	36	34	31⅓	100	80	100	.129	.170	.196	29.350	29.341	29.389	29.360
W 5......	29	44	32	35	100	84	100	.160	.241	.181	29.456	29.447	29.404	29.436
T 6......	31	44	38	37⅔	89	76	91	.155	.218	.208	29.359	29.249	29.139	29.249
F 7......	34	37	33	34⅔	100	100	100	.196	.221	.188	29.080	29.017	28.968	29.022
S 8......	33	39	32	34⅔	100	82	100	.188	.195	.181	28.977	28.975	29.001	28.984
S 9......	33	43	32	36	80	75	100	.150	.209	.181	29.048	29.075	29.089	29.071
M 10.....	38	53	35	42	81	60	90	.186	.244	.183	29.156	29.139	29.041	29.112
T 11......	45	58	44	49	68	82	100	.204	.394	.289	28.952	28.902	28.921	28.925
W 12......	48	65	56	56⅓	85	53	94	.285	.330	.420	29.040	29.083	29.139	29.087
T 13......	53	79	63	65	93	66	94	.375	.651	.543	28.982	28.835	28.736	28.851
F 14......	51	61	37	49⅔	93	45	90	.348	.242	199	28.829	28.991	29.150	28.990
S 15......	39	52	40	43⅔	91	73	91	.216	.282	.225	29.217	29.099	29.041	29.119
S 16......	39	50	44	44⅓	91	44	84	.216	.193	.241	29.069	29.046	28.993	29.036
M 17......	44	68	62	58	84	69	72	.241	.476	.399	29.023	29.041	28.961	29.008
T 18......	58	73	55	62	76	63	100	.365	.510	.433	28.904	28.938	28.827	28.890
W 19......	44	62	46	50⅔	76	66	100	.218	.370	.311	29.049	29.099	29.132	29.093
T 20......	52	75	64	63⅔	93	68	77	.361	.591	.464	29.196	29.164	29.164	29.175
F 21......	63	77	65	68⅓	72	69	89	.416	.639	.549	29.229	29.178	29.077	29.161
S 22......	55	68	54	59	94	79	93	.405	.543	.390	29.186	29.164	29.219	29.190
S 23......	50	65	54	56⅓	100	78	93	.361	.483	.390	29.217	29.189	29.185	29.197
M 24......	55	73	57	61⅔	94	77	100	.405	.617	.466	29.164	29.083	29.091	29.113
T 25......	60	76	58	64⅔	94	68	94	.487	.614	.452	29.060	29.033	29.047	29.047
W 26......	55	80	69	68	100	70	75	.433	.717	.529	29.110	29.064	29.083	29.086
T 27......	68	83	68	73	79	50	72	.543	.558	.543	29.009	28.862	28.843	28.905
F 28......	68	74	57	66⅓	85	67	94	.577	.568	.436	28.847	28.989	29.097	28.978
S 29......	66	86	70	74	89	62	85	.570	.762	.621	29.099	29.052	29.029	29.060
S 30......	70	83	71	74⅔	80	72	86	.586	.802	.644	29.046	28.992	29.025	29.021
Sums.....	......	......	......	......	......	......	......	......	......	......	....	....	....	....
Means....	......	......	......	51.4	87.4	70.1	90.9	.303	.408	.341	....	....	....	29.095
Average .	......	......	......	......		82.8			.351		....	....	....	....

APRIL, 1899, AT AGRICULTURAL COLLEGE, LANSING, MICHIGAN.

Clouds.						Winds.						Registering thermom'r.		Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
60	Cir.Cu.	80	Cir.Cu.	100	Cir.St.	n w	7	n w	....	n w	....	32	18	....	....	......	......
100	Cir.St.	100	Cir.St.	100	....	s w	....	s w	....	w	....	30	10	....	....	......	......
....	....	60	Cir.Cu.	....	....	n	....	....	....	n	....	36	10	....	....	......	......
....	....	....	....	....	....	n	....	n	4	....	0	44	19	....	....	......	......
....	....	....	....	....	....	n w	1	n w	5	n	1	44	26	....	....	......	......
100	Cu.	80	Cu.	100	Cu.	s e	5	s e	3	....	0	45	28	Snow in	night.	*	......
100	Nim.	100	Cu.	100	Cu.	s e	1	n e	4	n	4	37	32	....	....	......	......
100	Cu.	100	Cu.	....	....	n	4	n	5	n	4	44	32	....	....	......	......
....	....	....	....	....	....	n w	6	n w	....	n w	....	43	26	....	....	......	......
....	....	20	Cu.	....	....	s w	....	s w	7	s e	12	55	26	....	....	......	......
40	Cir.	100	Cu.	....	....	s e	15	s	6	s	1	61	32	....	....	......	......
....	....	30	Cir.	....	....	s	4	s w	9	s	8	67	35	....	....	......	......
....	....	20	Cu.	....	....	s e	9	s	19	s e	12	79	44	Rain in	night.	.04	......
60	Cu.	....	....	....	....	n w	12	w	15	n w	3	60	36	....	....	......	......
....	....	100	Cu.	....	....	n	4	s w	12	w	2	55	32	....	....	......	......
20	Cu.	80	Cu.	80	Cu.	w	10	w	14	s w	12	50	33	....	....	......	......
80	Cu.	20	Cu.	50	Cu.	s w	13	s w	17	s w	13	70	42	....	....	......	......
75	Cu.	40	Cu.	100	Cu.	s e	19	s e	12	s	9	75	36	†	....	.24	......
30	Cir.	10	Cu.	....	....	s w	7	...	0	s e	1	64	35	....	....	......	......
25	Cu.	....	....	50	Cu.	s	5	s	6	s e	5	75	50	....	....	......	......
50	Cu.	30	Cu.	80	Cu.	s w	6	s w	5	e	4	80	50	....	....	......	......
25	Cu.	10	Cu.	80	Cu.	n e	4	e	5	n e	3	67	54	....	....	......	......
60	Cir.Cu.	....	....	100	Cu.	e	5	e	4	s e	2	65	45	....	....	......	......
60	Cir.Cu.	100	Cu.	100	Cu.	s e	2	s e	2	s	2	76	48	....	....	......	......
80	Cu.	80	Cu.	....	....	s	2	s	4	s	2	76	54	‡	....	.18	......
....	....	....	....	....	....	s w	2	s w	6	s e	2	83	47	....	....	......	......
....	....	....	....	100	Cu.	s e	10	s	18	s	16	82	64	....	....	......	......
20	Cu.	....	....	....	....	s e	16	w	9	w	1	76	57	....	....	......	......
....	....	....	....	100	Cu.	w	5	s w	9	s w	7	86	64	Rain in	night.	.77	......
80	Cir.Cu.	100	Cu.	100	Nim.	s w	8	s	6	s	4	83	66	§	....	.33	......
....	....	....	....	....	....	....	....	....	....	....	....	......	......	....	....	1.56	......
39	....	42	....	45	....	....	....	....	....	....	....	61.2	38.4	....	....	......	......
		42				....	....	....	....	....	....	......	......	....	....	......	......

* Trace. † Rain in night; 7 a. m. ‡ Rain, 5 p. m.; 5:30. § Rain in night; 7 a. m.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air. 7 A. M.	2 P. M.	9 P. M.	Daily mean.	Relative humidity, or per cent of saturation. 7 A. M.	2 P. M.	9 P. M.	Pressure of vapor, in inches. 7 A. M.	2 P. M.	9 P. M.	Barometer reduced to freezing point. 7 A. M.	2 P. M.	9 P. M.	Mean.
M 1......	70	76	60	68⅔	90	86	94	.658	.772	.487	28.997	28.914	28.977	28.963
T 2......	60	82	64	68⅔	88	67	77	.456	.731	.464	29.052	29.027	29.076	29.052
W 3......	55	72	59	62	68	81	76	.295	.631	.380	29.098	29.067	29.101	29.089
T 4......	54	60	55	56⅓	87	100	87	.362	.518	.376	29.093	29.127	29.150	29.123
F 5......	55	72	52	59⅔	81	62	93	.349	.489	.361	29.182	29.269	29.279	29.243
S 6......	55	75	55	61⅔	87	60	87	.376	.519	.376	29.303	29.267	29.269	29.280
S 7......	56	72	60	62⅔	87	72	88	.391	.559	.456	29.197	29.033	28.971	29.067
M 8......	52	69	51	57⅓	86	70	100	.334	.496	.374	28.913	29.016	29.002	28.977
T 9......	69	73	50	64	77	81	100	.446	.655	.361	29.059	29.020	29.009	29.029
W 10......	62	74	56	64	83	77	100	.460	.641	.449	29.006	28.916	28.829	28.917
T 11......	56	72	56	61⅓	87	81	87	.391	.631	.391	28.923	28.921	28.939	28.928
F 12......	66	75	51	64	89	77	100	.570	.666	.374	28.927	28.827	28.780	28.845
S 13......	55	60	42	52⅓	87	76	91	.376	.396	.244	29.088	29.147	29.267	29.167
S 14......	46	55	48	49⅔	92	87	92	.286	.376	.310	29.391	29.367	29.317	29.358
M 15......	45	53	50	49⅓	92	86	100	.275	.348	.361	29.381	29.343	29.167	29.297
T 16......	60	69	47	58⅔	100	100	100	.518	.708	.323	28.977	28.846	29.005	28.943
W 17......	50	63	60	57⅔	100	83	88	.361	.478	.456	28.977	28.899	29.023	28.966
T 18......	50	52	47	49⅔	85	86	92	.309	.334	.298	29.047	29.071	29.177	29.098
F 19......	45	55	43	47⅔	84	74	75	.251	.321	.209	29.223	29.193	29.211	29.209
S 20......	45	57	42	48	76	81	91	.228	.378	.244	29.223	29.197	29.217	29.212
S 21......	51	60	50	53⅔	93	76	85	.348	.396	.309	29.231	29.267	29.273	29.257
M 22......	49	57	44	50	92	75	84	.322	.350	.241	29.254	29.297	29.367	29.306
T 23......	51	67	46	54⅔	93	84	92	.348	.556	.286	29.389	29.380	29.347	29.372
W 24......	60	71	59	63⅓	76	72	94	.396	.572	.469	29.356	29.284	29.225	29.288
T 25......	63	77	58	66	88	73	88	.510	.678	.423	29.209	29.182	29.169	29.187
F 26......	66	74	63	67⅔	84	81	94	.536	.680	.543	29.150	29.077	28.997	29.075
S 27......	66	63	63	64	94	100	100	.604	.576	.576	28.882	28.897	28.902	28.894
S 28......	60	75	65	66⅔	100	90	94	.518	.785	.583	28.941	28.935	28.971	28.949
M 29......	67	70	61	66	89	90	94	.591	.658	.505	28.911	28.940	28.954	28.935
T 30......	63	76	61	66⅔	83	68	94	.478	.614	.505	29.095	29.091	29.041	29.076
W 31......	63	80	70	71	100	70	95	.576	.717	.695	28.905	28.837	28.847	28.863
Sums	......	......	......	......	......	......	......	......	......	......	....	....	....	....
Means....	......	......	......	59.77	87.7	79.5	91.4	.417	.556	.401	....	....	....	29.096
Average..	......	......	......	......		86.2			.458		....	....	....	....

MAY, 1899, AT AGRICULTURAL COLLEGE, LANSING, MICHIGAN.

Clouds.						Winds.						Registering thermom'r.		Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
100	Nim.					s e	18	s e	14	s w	2	82	60				
		40	Cu.	100	Cu.	s w	2	n e	2	e	6	82	56		In night.	.40	
20	Cu.	50	Cir.	30	Cir.	w	3	w	11	e		72	51		In night.	.02	
100	Cu.	100	Cu.			s w		s w		s e		63	50	*	12:00	.06	
						s e		s w	4	s w	1	74	42				
100	Cu.					s w	2	s w	5	s w	1	75	45				
		100	Cu.	100	Cu.	s e	2	s e	7	s e	2	73	45				
100	Cu.	25	Cu.	90	Cu.	n w	2	n e	5	s e	1	71	42				
10	Cu.	20	Cu.	80	Cu.	s e	2	s e	4	s w	1	73	42				
30	Cu.	10	Cu.	100	Cu.	s w	5	s w	12	w	7	75	46	†	6:30 pm	.48	
						s w	5	s w	12	w	6	72	50				
10	Cir.	80	Nim.	50	Cu.	s	5	s e	8	n e	3	73	50				
						n w	9	n w	12	n w	1	60	42				
		100	Cu.	100	Cu.	s e	2	n w	3	n w	1	57	40	Rain in night.		‡	
100	Cu.	80	Cir.Cu.	100	Cu.	n e	3	e	6	s e	3	60	40	Rain in night.		.18	
100	Cu.	80	Cu.	100	Cu.	s e	2	s	10	s e	3	75	47	10:30 am	12 m.	.86	
100	Cir.Cu.	100	Nim.	100	Cu.	s e	3	s	3	s e	2	68	48	10 a. m.	1 p. m.	.18	
100	Cu.	80	Cu.	50	Cu.	n w	9	n w	8	n w	5	56	47				
100	Cu.	100	Cu.			n w	6	n e	4	n w	4	57	37				
20	Cu.	20	Cu.			n w	3	n w	4		0	60	34				
40	Cir.					n w	1	n w	2		0	61	42				
60	Cir.	100	Cu.			e	4	e	5	e	1	58	34				
		60	Cu.			s e	3	s e	4		0	69	37				
							0	s w	5	s w	4	79	39				
		60	Cu.	50	Cir.	s w	4	s w	7	s w	1	79	46				
80	Cu.	100	Cu.	100	Cu.	s e	4	s w	1	s w	8	76	56	12:30 pm	4:00	.16	
100	Nim.	100	Cu.	100	Cu.	w	3	s w	11	s w	3	75	60	6:30 am	11:30 am	.70	
80	Cu.	100	Cu.	100	Cu.	n w	1	s w	8		0	79	60		In night.	.19	
100	Cir.Cu.	100	Cu.			w	7	w		s w	6	75	59		In night.	.02	
				20	Cir.	s w	5	s w	8	s e	2	75	56				
100	Nim.	60	Cu.			s w	8	s w	13	s w	5	83	56	7 a. m.	8:30 am	.34	
																3.59	
50		54		44								70.5	47.1				
49																	

* Rain 11:30. † Rain 3 p. m. ‡ Trace.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.				Relative humidity, or per cent of saturation.			Pressure of vapor, in inches.			Barometer reduced to freezing point.			
	7 A. M.	2 P. M.	9 P. M.	Daily mean.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Mean.
T 1......	70	78	58	68⅔	90	78	88	.658	.744	.423	28.877	28.920	29.051	28.949
F 2......	57	71	57	61⅔	87	76	94	.407	.572	.436	29.155	29.184	29.189	29.176
S 3......	58	82	70	70	94	71	90	.452	.773	.658	29.190	29.068	29.052	29.103
S 4......	78	88	77	81	78	73	91	.744	.962	.841	29.027	28.942	28.964	28.978
M 5......	81	89	70	80	87	69	85	.918	.948	.621	29.004	28.969	29.065	29.013
T 6......	77	87	70	78	86	76	90	.799	.976	.612	29.085	29.042	29.065	29 064
W 7......	77	87	66	76⅔	91	72	94	.841	.928	.604	29.045	28.987	29.071	29.034
T 8......	64	74	65	67⅔	89	67	94	.529	.568	.583	29.118	29.123	29.091	29.111
F 9......	66	70	58	64⅔	94	85	94	.604	.621	.452	29.087	29.097	29.131	29.105
S 10......	63	73	54	63⅓	83	72	93	.478	.581	.390	29.213	29.175	29.159	29.182
S 11......	65	75	55	65	73	77	81	.483	.666	.349	29.038	29.047	28.975	29.020
M 12......	64	82	71	72⅓	83	75	95	.497	.816	.720	28.982	28.984	28.976	28.981
T 13......	73	86	71	76⅔	85	80	95	.693	.989	.720	28.980	28.993	29.003	28.992
W 14......	75	84	70	76⅓	90	75	100	.785	.877	.733	29.043	28.983	29.063	29.030
T 15......	64	68	51	61	83	75	100	.497	.509	.374	29.091	29.145	29.256	29.164
F 16......	53	67	52	57⅓	86	79	93	.348	.522	.361	29.343	29.323	29.349	29.338
S 17......	64	75	55	64⅔	83	77	100	.497	.666	.433	29.357	29.314	29.229	29.300
S 18......	65	80	63	69⅓	89	78	100	.549	.800	.576	29.153	29.053	29.041	29.082
M 19......	72	87	70	76⅓	86	76	100	.668	.976	.733	29.042	28.953	28.898	28.964
T 20......	73	80	55	69⅓	85	78	100	.693	.800	.433	28.966	28.986	29.102	29.018
W 21......	62	75	63	66⅔	83	73	83	.460	.628	.478	29.203	29.184	29.155	29.181
T 22......	69	92	78	79⅔	70	74	78	.496	1.108	.744	29.095	29.047	29.150	29.097
F 23	71	83	62	72	86	72	100	.644	.802	.556	29.228	29.203	29.295	29.242
S 24.....	77	71	68	72	86	86	79	.644	.644	.543	29.272	29.231	29.239	29.247
S 25......	70	81	60	70⅓	80	59	88	.586	.624	.456	29.264	29.256	29.275	29.265
M 26......	62	81	59	67⅓	100	59	100	.556	.624	.500	29.300	29.256	29.238	29.265
T 27......	73	85	70	76	85	57	75	.693	.691	.551	29.249	29.206	29.123	29.193
W 28......	71	73	56	66⅔	76	90	97	.572	.732	.427	28.886	28.846	29.174	28.969
T 29......	66	73	55	64⅔	78	85	100	.502	.693	.433	29.317	29.329	29.295	29.314
F 30......	67	81	64	70⅔	79	66	77	.522	.704	.464	29.374	29.307	29.281	29.321
Sums	......	......	......	......	......	......	......	......	......	......	....	....	....	....
Means....	......	......	......	70.2	84.8	74.3	91.8	.594	.751	.540	....	....	....	29.123
Average .	......	......	......	......	83.6			.628			....	....	....	....

Thunder storm June 3 (slight) 5, 6, 7 (slight) 14.

JUNE, 1899, AT AGRICULTURAL COLLEGE, LANSING, MICHIGAN.

Clouds.						Winds.						Registering thermom'r.		Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
60	Cir.	80	Cir.			s w	6	s w	6	s w	2	77	58				
						n w	2	s w	2	....	0	71	54				
100	Cu.	80	Cu.			s e	6	s e	8	s w	11	81	52	7 a.m.	8 a.m.	‡	
						s w	7	s w	12	s w	5	79	68				
		40	Cu.	80	Cu.	s w	8	s w	12	s w	8	89	67	5 p.m.	7 p.m.	.27	
		50	Cu.	80	Cir.Cu.	s	2	s w	5	s w	3	89	66	*	8 p.m.	.27	
		85	Cu.	20	Cir.	s w	8	s w	....	n w	5	88	65	2 p.m.	†	.03	
						n w	5	n w	5	n w	....	76	57				
60	Cir.Cu.	50	Cu.			n w	....	n w	3	....	0	75	54				
40	Cir.	20	Cir.			....	0	s e	2	s e	5	73	53				
60	Cir.Cu.	60	Cu.			s e	10	s w	8	s w	8	76	45				
100	Cu.	60	Cu.			s w	7	s w	12	s w	4	84	60				
		60	Cu.			s w	7	s w	11	w	2	87	64				
100	Cu.	60	Cu.	100	Cu.	w	6	w	9	....	0	87	66	In night.		.30	
40	Cu.					n w	6	n w	10	n w	5	68	51				
						n w	4	n w	5	n w	3	71	51				
		20	Cu.			n w	2	n w	6	w	1	76	43				
100	Cu.					s w	4	s w	7	....	0	81	57				
				20	Cir.	s	2	s	6	....	0	88	66				
100	Cu.	40	Cu.	30	Cir.	n w	3	w	7	n e	3	81	54				
						n e	3	e	....	s e	7	77	45				
		20	Cu.			s	7	s w	11	s w	5	92	62				
				20	Cir.	w	4	s w	7	....	0	84	62				
60	Cir.	100	Cu.			s w	1	s w	6	s w	2	79	55				
				20	Cir.	n e	2	s w	3	w	1	81	51				
30	Cir.	20	Cu.			s w	1	s w	3	s w	1	83	49				
				80	Cir.	s w	6	s w	5	s w	5	86	49	In night.		.11	
100	Cu.	100	Cu.	40	Cir.	w	8	n w	6	n e	4	77	55	During day.		.17	
						n e	4	....	0	n e	1	74	47				
						s e	5	s e	4	s e	1	83	45				
950		945		490												1.15	
32		32		16								80.4	55.7				
.27																	

* 5:30 p. m. † 2:30 p. m. ‡ Trace.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.				Relative humidity, or per cent of saturation.			Pressure of vapor, in inches.			Barometer reduced to freezing point			
	7 A. M.	2 P. M.	9 P. M.	Daily mean.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Mean.
S 1......	67	88	64	73	75	69	77	.489	.915	.464	29.255	29.121	29.083	29.153
S 2......	68	88	68	74⅔	79	69	79	.543	.915	.543	29.121	29.067	29.114	29.101
M 3......	73	87	69	76⅓	85	69	100	.693	.882	.708	29.140	29.072	29.097	29.103
T 4......	67	76	69	70⅔	89	82	95	.591	.785	.671	29.077	29.057	29.002	29.045
W 5......	69	75	62	68⅔	95	90	100	.671	.785	.556	29.001	28.957	28.996	28.985
T 6......	65	78	64	69	94	82	100	.583	.785	.596	29.027	29.044	29.071	29.047
F 7......	68	79	67	71⅓	100	78	84	.685	.772	.556	29.025	29.049	28.977	29.017
S 8......	55	73	57	61⅔	100	77	87	.433	.617	.407	29.019	29.086	29.200	29.102
S 9......	67	77	60	68	84	82	100	.556	.758	.500	29.207	29.176	29.184	29.189
M 10......	62	74	64	66⅔	100	86	100	.556	.718	.596	29.179	29.140	29.116	29.145
T 11......	71	86	61	72⅔	90	76	100	.682	.942	.537	29.117	29.072	29.128	29.106
W 12......	71	83	70	74⅔	90	75	100	.682	.846	.733	29.161	29.101	29.136	29.133
T 13......	60	63	63	62	100	100	100	.518	.576	.576	29.161	29.104	29.034	29.099
F 14......	64	74	69	69	100	100	95	.596	.839	.671	29.065	29.029	28.991	29.028
S 15......	68	72	69	69⅔	100	100	95	.685	.785	.671	28.987	28.880	28.891	28.919
S 16......	72	80	69	73⅔	90	78	95	.706	.800	.671	28.974	28.978	29.040	28.997
M 17......	68	74	58	66⅔	95	81	94	.648	.680	.452	29.091	29.143	29.217	29.184
T 18......	64	82	64	70	89	71	100	.529	.773	.596	29.207	29.114	29.111	29.144
W 19......	63	77	64	68	94	82	100	.543	.758	.596	29.099	29.046	29.040	29.062
T 20......	71	86	69	75	90	65	95	.682	.805	.671	28.992	28.933	29.004	28.976
F 21......	75	84	62	73⅔	87	79	94	.745	.923	.523	28.997	29.013	29.174	29.061
S 22......	63	83	73	72⅓	88	75	95	.510	.846	.771	29.085	28.972	29.034	29.030
S 23......	74	92	70	78⅔	81	64	90	.680	.956	.658	29.033	28.989	28.993	29.005
M 24......	71	95	76	80⅔	95	62	86	.720	1.015	.772	28.990	28.956	28.990	28.978
T 25......	68	75	66	69⅔	95	90	100	.648	.785	.639	29.025	28.992	28.979	28.999
W 26......	73	84	73	76⅔	85	83	90	.693	.969	.732	29.016	29.060	29.167	29.081
T 27......	75	76	61	70⅔	87	73	94	.745	.652	.505	29.095	29.015	29.162	29.091
F 28......	69	82	65	72	79	63	100	.564	.691	.618	29.098	29.159	28.999	29.089
S 29......	73	74	51	66	90	77	93	.732	.641	.348	29.073	28.992	29.067	29.044
S 30......	62	71	52	61⅔	77	90	100	.429	.682	.388	29.123	29.058	29.097	29.093
M 31......	61	80	64	68⅓	77	62	100	.413	.638	.596	29.129	29.042	29.087	29.086
Sums......	......	......	......	2191⅔	......	......	......	......	......	......	......	......	......	......
Means......	......	......	......	70.7	89.7	78.4	94.4	.611	.795	.591	......	......	......	29.065
Average......	......	......	......	......		87.5			.669		......	......	......	......

JULY, 1899, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Registering thermom'r.		Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
20	Cir.	....	....	...	....	s e	5	s w	9	s w	1	89	62	....	....	......	......
....	....	80	Cu.	100	Nim.	w	5	s w	7	s w	1	89	58	10 p. m.	10:30 pm	*	......
80	Cu.	80	Cu.	100	Cu.	s w	3	s w	7	s w	0	87	62	2:30 p m	3 p. m.	12	......
100	Nim.	100	Nim.	100	Nim.	s	6	s	7	s	2	78	66	†	‡	......	......
100	Nim.	100	Nim.	60	Cu.	e	4	e	4	s w	1	78	62	‡	5 p. m.	.83	......
80	Cu.	60	Cu.	....	....	s w	2	s w	3	s w	1	82	62	....	....	......	......
100	Nim.	60	Cu.	60	Cu.	s w	4	s w	12	n w	4	81	62	6:30 am	7 a. m.	.02	......
100	Nim.	40	Cu.	....	....	n e	6	n e	9	n e	3	74	55	6 a. m.	8:30 am	.08	......
....	....	....	....	50	Cir.	e	3	s e	5	s e	0	78	55	....	....	......	......
100	Nim.	60	Cu.	....	....	s e	2	s w	4	s w	1	79	50	6:30 am	7 a. m.	*	......
....	....	50	Cu.	....	....	s w	5	s w	6	s w	3	86	50	....	....	......	......
....	....	90	Cir.Cu.	80	Cir.	s w	....	n w	8	n w	3	86	53	....	....	......	......
100	Nim.	100	Nim.	100	Cu.	n e	2	n e	....	n e	....	64	59	5 a. m.	3 p. m.	.48	......
100	Cu.	100	Cu.	100	Cu.	n e	2	n e	1	n e	....	77	62	....	....	......	......
100	Nim.	100	Cu.	....	....	e	6	s e	5	w	2	74	63	6 a. m.	1 p. m.	.05	......
80	Cu.	80	Cu.	....	....	n w	4	n e	....	n e	....	82	67	....	....	......	......
100	Cu.	50	Cu.	....	....	n w	....	n w	7	n e	2	77	58	....	....	......	......
....	....	40	Cu.	....	....	s e	5	w	9	s w	2	82	48	....	....	......	......
100	Cu.	50	Cu.	10	Cir.	s w	3	s w	3	s w	1	78	57	§	‖	*.18	......
....	....	10	Cu.	....	....	s w	5	s w	12	s w	3	86	61	....	....	......	......
20	Cu.	80	Cu.	80	Cir.	s w	6	s w	5	w	3	86	58	....	....	......	......
....	....	10	Nim.	....	....	s e	4	s e	4	s	4	84	53	....	....	......	......
....	....	10	Cu.	....	....	s e	6	s e	....	e	....	92	61	....	....	......	......
10	Cir.	10	Cu.	100	Nim.	e	6	s e	4	s w	3	96	59	9:30 pm	....	......	......
100	Nim.	80	Nim.	....	....	s e	4	s w	4	s	....	85	65	....	10:30 am	.35	......
....	....	....	....	....	....	s w	4	s w	5	s w	....	89	59	....	....	......	......
90	Cir.	50	Cir.	80	Cu.	s w	2	n w	9	s w	4	86	58	....	....	......	......
10	St.	50	Cu.	....	....	s w	3	s w	....	s w	....	84	55	....	....	......	......
90	Cir.	100	Nim.	....	....	s w	....	s w	3	....	....	78	50	....	....	......	......
10	Cir.	....	....	....	....	e	8	e	....	s e	....	72	48	....	....	......	......
....	....	90	Cir.	20	Cu.	s w	3	s e	5	s w	....	83	43	....	....	......	......
....	....	....	....	....	....	....	....	....	....	...	....	......	......	....	....	2.11	......
51.3	....	55.8	....	33.6	....	....	....	....	....	....	....	81.0	55.5	....	....	......	......
		46.9				....	....	....	....	....	....	......	......	....	....	......	......

* Trace. † In night. ‡ Continued. § 6:30 a. m., 3:00 p. m. ‖ 7:00, 4:00 p. m.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.				Relative humidity, or per cent of saturation.			Pressure of vapor, in inches.			Barometer reduced to freezing point.			
	7 A. M.	2 P. M.	9 P. M.	Daily mean.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Mean.
T 1......	71	84	71	75⅓	90	60	95	.682	.704	.720	29.081	29.030	29.037	29.049
W 2......	71	80	66	72⅓	90	70	100	.682	.717	.639	29.061	29.084	29.161	29.102
T 3......	67	71	71	69⅔	95	90	95	.626	.682	.720	29.111	29.023	28.977	29.037
F 4......	71	82	70	74⅓	90	79	100	.682	.859	.733	28.986	28.971	28.986	28.981
S 5......	67	74	62	67⅔	95	90	100	.626	.758	.556	29.023	29.017	29.061	29.030
S 6......	65	77	57	66⅓	84	65	100	.516	.601	.466	29.147	29.125	29.121	29.131
M 7......	63	77	57	65⅔	88	69	87	.510	.639	.407	29.140	29.107	29.151	29.133
T 8......	62	80	65	69	61	62	100	.340	.638	.618	29.155	29.144	29.131	29.133
W 9......	68	81	70	70	69	66	95	.476	.704	.695	29.057	28.936	28.849	28.927
T 10......	74	89	73	78⅔	90	75	95	.758	.997	.771	28.652	28.934	28.914	28.833
F 11......	77	85	81	81	77	68	74	.717	.819	.787	28.872	28.997	28.855	28.908
S 12......	74	86	61	73⅔	81	49	94	.680	.650	.505	28.907	28.939	29.005	28.950
S 13......	62	66	60	62⅔	83	84	94	.460	.536	.587	29.142	29.091	29.168	29.134
M 14......	59	78	57	64⅔	82	65	87	.410	.601	.407	29.241	29.176	29.259	29.225
T 15......	59	80	55	64⅔	76	51	100	.380	.523	.433	29.279	29.257	29.235	29.257
W 16......	58	84	69	70⅓	82	50	95	.394	.584	.671	29.238	29.181	29.137	29.185
T 17......	68	91	67	75⅓	90	60	89	.612	.874	.591	29.135	29.094	29.075	29.101
F 18......	70	93	67	76⅔	75	64	100	.551	.992	.662	29.111	29.062	29.050	29.074
S 19......	76	93	74	81	41	58	81	.369	.894	.680	29.088	29.036	28.993	29.039
S 20......	80	93	78	83⅔	78	55	82	.800	.847	.785	28.955	28.831	28.820	28.869
M 21......	68	79	64	70⅓	90	69	100	.612	.691	.596	28.772	28.811	28.989	28.857
T 22......	70	83	65	72⅓	75	60	100	.551	.677	.618	29.097	29.108	29.144	29.116
W 23......	58	86	65	69⅔	82	39	100	.394	.480	.618	29.199	29.104	29.057	29.120
T 24......	69	88	68	75	85	66	100	.599	.868	.685	29.041	28.983	29.141	29.055
F 25......	64	84	63	70⅓	77	40	100	.464	.470	.576	29.158	29.130	29.211	29.166
S 26......	62	87	60	69⅓	88	60	100	.491	.792	.518	29.097	28.993	29.117	29.069
S 27......	74	91	65	76⅔	81	57	68	.680	.827	.420	29.138	29.154	29.258	29.183
M 28......	68	89	65	74	60	51	94	.411	.707	.583	29.292	29.247	29.289	29.276
T 29......	72	92	66	76⅔	72	51	89	.559	.768	.570	29.266	29.206	29.223	29.232
W 30......	72	92	72	78⅔	81	54	90	.631	.814	.706	29.206	29.128	29.121	29.152
T 31......	73	84	76	77⅔	81	83	95	.655	.969	.854	29.175	29.165	29.110	29.150
Sums	......	......	......	......	......	......	......	......	......	......	....	....	....	....
Means....	......	......	......	76.56	80.3	63.2	93.5	.559	.732	.618	....	....	....	29.080
Average..	......	......	......	......	79.0			.636			....	....	....	....

AUGUST, 1899, AT AGRICULTURAL COLLEGE, LANSING, MICHIGAN.

Clouds.						Winds.						Registering thermom'r.		Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
		60	Cu.			s w	6	s w	11	s w	4	87	56				
		60	Cir.Cu.			s w	7	n w	6	n	4	82	66				
100	Cir.Cu.	100	Cu.	100	Cu.	n e		s w	5	s e	1	75	60	11 a. m.	*	.03	
100	Cu.	50	Cu.	100	Cu.	w	3	w	2	n	1	85	64				
100	Nim.	80	Cir.Cu.			n e	1	e	1	s e	2	77	62	†	12 m.	.10	
						n w	2	n e	3	n e	0	77	57				
						n e	1	n e	3	n e		77	47				
50	Cir.					n	7	s e	5	s e	5	82	52				
		100	Cu.	30	Cir.	s	10	s e	9	s w	3	83	54				
40	Cir.	80	Nim.	100	Nim.	s w	6	s w	5	s w	10	90	66				
		50	Cir.	100	Nim.	s e	12	s	4	s w	12	89	60	‡	§	.02	
						s w	6	s w	10	n w	3	66	61				
80	Cir.	100	Cu.			s w	4	s w		s w		74	58				
10	Cu.	50	Cir.			s e	4	s e	5	n e	2	78	46				
						n e	2	s e	3	s e	0	82	45				
						n e	2	s e	5	s e	0	88	41				
						s e	4	s e	5	s	1	93	49				
		20	Cir.	20	Cir.	s	1	s w	5	s w	1	95	62				
						s w	3	s w	4	n w	0	97	52				
10	Cir.	80	Cir.	100	Nim.	s w	4	s w	11	s w	10	94	60				
		80	Nim.			s w	8	w	8	s w		87	63				
		10	Cir.			s w	4	s w	3	s w	5	85	52				
				50	Cu.	s w	4	s	6	s e	1	86	51				
100	Nim.	100	Cir.	10	Cir.	s w	5	s w	5	s w	1	90	59	‖		¶	
10	Cir.	20	Cir.			s w	3	s w	4	s	1	84	59				
100	Nim.	10	Cir.			s w	1	s w	8	s w	1	87	54				
		60	Cir.Cu.			s e	2	s e	3	s e	0	92	51				
						s	1	s w	5	s w	1	90	63				
		30	Cir.	20	Cu.	s w	5	s w	6	s w	6	92	56				
						s w	5	s w	7	s w	2	93	57				
80	Cir.Cu.	100	Cu.	100	Nim.	s	2	s w	2	s w	3	86	68	**	††	.55	
																.70	
24.5		40.0		23.6								89	56				
29.4																	

* 12:30 p. m. † 6:30 a. m. ‡ 9:30 p. m. § In night. ‖ 7:30 a. m. ¶ Trace. ** 8:45 p. m. †† In night.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of Month.	Thermometer, in open air.				Relative humidity, or per cent of saturation.			Pressure of vapor, in inches.			Barometer reduced to freezing point.			
	7 A. M.	2 P. M.	9 P. M.	Daily mean.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 P. M.	2 P. M.	9 P. M.	Mean.
F 1......	71	85	70	75⅓	100	79	100	.759	.955	.733	29.120	29.227	29.236	29.194
S 2......	72	91	73	78⅔	90	70	95	.706	1.019	.771	29.242	29.094	29.060	29.132
S 3......	73	85	60	72⅔	90	65	88	.732	.775	.456	29.007	29.048	29.097	29.051
M 4......	56	76	65	65⅔	87	68	89	.391	.614	.549	29.177	29.135	29.078	29.130
T 5......	67	85	74	75⅓	95	75	90	.626	.909	.798	29.011	28.999	29.080	29.030
W 6......	57	71	62	63⅓	94	80	94	.436	.608	.523	29.342	29.258	29.193	29.264
T 7......	70	94	73	79	85	68	95	.621	1.080	.771	29.084	29.015	29.013	29.037
F 8......	65	68	55	62⅔	89	79	100	.549	.543	.433	29.088	29.153	29.266	29.169
S 9......	52	68	53	57⅔	93	75	100	.361	.509	.403	29.261	29.285	29.321	29.289
S 10......	58	67	58	61	82	84	94	.394	.556	.452	29.304	29.188	29.105	29.199
M 11......	55	74	59	62⅔	94	67	88	.405	.568	.439	29.048	28.999	28.948	28.996
T 12......	62	71	53	62	88	62	86	.491	.469	.348	28.855	29.005	29.048	28.969
W 13......	49	62	43	51⅓	85	61	92	.297	.340	.254	29.145	29.124	29.258	29.176
T 14......	41	63	39	47⅔	82	72	100	.212	.416	.238	29.409	29.366	29.383	29.386
F 15......	49	71	60	60	78	86	76	.272	.644	.396	29.336	29.271	29.333	29.313
S 16......	61	90	76	75⅔	77	56	81	.413	.796	.731	29.294	29.172	29.183	29.216
S 17......	72	87	65	74⅔	86	69	94	.668	.882	.583	29.160	29.121	29.121	29.134
M 18......	62	57	56	58⅓	100	100	94	.556	.466	.420	29.037	29.069	29.187	29.098
T 19......	50	51	49	50	100	100	92	.361	.374	.322	29.209	29.207	29.240	29.219
W 20......	45	60	58	54⅓	92	76	97	.275	.396	.459	29.190	29.108	29.112	29.137
T 21......	41	67	50	52⅔	74	75	100	.190	.489	.361	29.141	29.165	29.064	29.123
F 22......	47	47	45	46⅓	100	100	100	.323	.323	.300	29.266	29.282	29.295	29.281
S 23......	46	56	47	49⅔	92	87	100	.286	.391	.323	29.286	29.213	29.112	29.204
S 24......	57	50	49	52	94	100	92	.436	.361	.322	28.954	28.828	28.841	28.874
M 25......	47	51	46	48	92	93	92	.298	.348	.286	28.942	29.021	29.129	29.031
T 26......	40	53	36	43	91	73	100	.225	.295	.212	29.173	29.130	29.110	29.138
W 27......	35	61	50	48⅔	90	71	85	.183	.383	.309	29.117	29.040	29.008	29.055
T 28......	54	51	44	49⅔	80	79	76	.335	.296	.218	28.865	28.958	29.116	28.980
F 29......	41	54	37	44	91	80	81	.235	.335	.178	29.167	29.185	29.295	29.216
S 30......	33	44	31	36	89	68	78	.168	.196	.136	29.490	29.468	29.516	29.491
Sums.....	......	......	......	......	......	......	......	......	......	......	....	....	....	....
Means....	......	......	......	58.60	89.3	76.6	91.8	.403	.545	.424	....	....	....	29.151
Average..	......	......	......	......		85.9			.457		....	....	....	....

SEPTEMBER, 1899, AT AGRICULTURAL COLLEGE, LANSING, MICHIGAN.

Clouds.						Winds.						Registering thermom'r.		Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
100	Cir. Cu.	80	Cir.			s	4	s e		s e		85	65				
100	Cu.	50	Cir. Cu.			s		s w	6	s w	2	91	68				
100	Cir.					s w	4	w	5	s w	2	84	45				
10	Cu.	10	Cir.			s w	6	s w	7	s e	4	79	56				
100	Cir. Cu.	10	Cu.	100	Cu. Nim	s w	5	s w	9	s	2	87	55	6:30 a.m	11 a. m.	.33	
100	Cir. Nim.	80	Cu.			w	1	s	3	s w	4	71	55	6 a. m.	10 a. m.	.34	
90	St. Cu.	10	Cu.	25	Cir.	s	6	s w	11	s w	3	94	62				
100	Cu. Nim	100	Cir. Cu.			s w	3	s w		s w	.	69	44	10:30	Trace.		
100	Cir.	80	Cu.			s		s e	3	s w	0	72	46				
100	Cir. Cu.	100	Cir. St.	100	Cu. St.	s w	2	s w	4	s	1	63	50				
100	St.	40	Cu.	20	Al. St.	n w	3	n w	7	w	4	75	50				
		30	Cu.			w	3	w	10	n w	3	74	39				
		50	Cu.			n w	7	n w	6	n	1	66	31				
						n w	2	n e	2	n	0	63	34				
90	Cir. Cu.	80	Cir. Cu.	10	Cir.	n e	1	s e	5	s e	6	72	49				
10	Cir.					s	6	s w	11	s w	5	91	62				
50	Cir.	50	Cir. Cu.	100	St.	s w	6	s w	7	n w	1	82	60	5 p. m.			
100	Nim.	100	Nim.	100	St.	n w	1	n w	4	n w	3	62	49		3 p. m.	.47	
100	Nim.	100	Nim.	100	St.	n w	2	n w	4	n w	2	54	43	1 p. m.	4 p. m.	.03	
50	Cir. Cu.	80	Cir. Cu.	20	Cir.	n w	4	n w	5	n w	8	62	32				
20	Al. Cu.	90	Al. Cu.			n w		s w	9	s w	1	67	52				
100	St.	100	St.	100	St.	n w	1	n w	1	n w	0	50	42	*	†	.34	
100	St.	90	Cu. St.	40	Cir. St.	n w	3	n		n w		58	46				
100	St.	100	St.	100	St.	n w		n w	2	n w	3	62	43	10 a. m.	7 p. m.	.46	
100	Cu. St.	100	St.	100	St.	n w	3	n w	3	n w	2	56	36	1:30 p.m	4 p. m.	.17	
		10	Cir.			n w	3	w	4	w		53	29				
		10	Cir. Cu.			n w	4	s w	8	s w	5	62	37				
90	Al. Cu.	100	Cu. St.	100	St.	s w	11	s w	15	w	3	60	38				
20	Cu. St.	100	St.	100	St.	n w	5	n w	6	n w	3	46	27				
40	Cir.	80	Cir. Cu.			n w	4	n w	5	n w		44	21				
																2.14	
62.3		61.0		37.2								68.5	44.9				
53.5																	

*5 a. m. 2 p. m. †10:30 a. m. Night.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air. 7 A. M.	2 P. M.	9 P. M.	Daily mean.	Relative humidity, or per cent of saturation. 7 A. M.	2 P. M.	9 P. M.	Pressure of vapor, in inches. 7 A. M.	2 P. M.	9 P. M.	Barometer reduced to freezing point. 7 A. M.	2 P. M.	9 P. M.	Mean.
S 1......	32	50	36	$39\frac{1}{3}$	79	58	80	.143	.210	.170	29.630	29.553	29.512	29.562
M 2......	42	58	46	$48\frac{2}{3}$	83	76	92	.222	.365	.286	29.569	29.500	29.501	29.523
T 3......	46	74	54	58	84	59	87	.262	.497	.362	29.443	29.313	29.404	29.387
W 4......	52	63	50	55	86	72	100	.334	.416	.361	29.465	29.362	29.376	29.401
T 5......	36	62	42	$46\frac{2}{3}$	90	83	100	.191	.460	.267	29.332	29.235	29.185	29.251
F 6......	38	62	39	$46\frac{1}{3}$	91	66	100	.208	.370	.238	29.224	29.176	29.106	29.169
S 7......	40	63	44	49	82	67	92	.203	.386	.265	29.200	29.144	29.193	29.179
S 8......	41	59	47	49	82	76	100	.212	.380	.323	29.140	29.044	29.013	29.066
M 9......	40	68	34	54	82	69	87	.203	.476	.362	29.015	29.026	28.996	29.012
T 10......	59	78	65	$67\frac{1}{3}$	76	78	84	.380	.744	.516	29.044	29.058	29.137	29.079
W 11......	61	64	62	$62\frac{1}{3}$	88	89	100	.473	.529	.556	29.189	29.193	29.243	29.208
T 12......	63	73	65	67	94	81	94	.543	.655	.583	29.240	29.189	29.204	29.211
F 13......	62	82	69	71	94	71	79	.523	.773	.564	29.198	29.116	29.122	29.145
S 14......	65	66	54	$61\frac{2}{3}$	94	84	87	.583	.536	.362	29.229	29.275	29.325	29.276
S 15......	68	85	69	74	95	61	79	.648	.733	.564	29.280	29.193	29.156	29.210
M 16......	61	80	58	$66\frac{1}{3}$	83	62	100	.442	.638	.483	29.111	28.969	28.988	29.023
T 17......	45	50	38	$44\frac{1}{3}$	100	100	100	.300	.361	.229	29.013	28.974	29.027	29.005
W 18......	37	59	40	$45\frac{1}{3}$	100	94	91	.221	.436	.225	29.069	29.145	29.189	29.134
T 19......	41	45	39	$41\frac{2}{3}$	91	100	100	.235	.300	.238	29.323	29.315	29.389	29.309
F 20......	35	51	38	$41\frac{1}{3}$	80	79	91	.162	.296	.208	29.469	29.507	29.554	29.510
S 21......	37	56	43	$45\frac{1}{3}$	81	69	92	.178	.308	.254	29.599	29.511	29.421	29.510
S 22......	48	71	62	$60\frac{1}{3}$	78	66	77	.260	.503	.429	29.340	29.238	29.235	29.271
M 23......	63	80	64	69	83	70	94	.478	.717	.563	29.219	29.195	29.286	29.233
T 24......	60	75	59	$64\frac{2}{3}$	82	81	88	.426	.705	.439	29.370	29.316	29.340	29.342
W 25......	53	75	59	$62\frac{1}{3}$	93	68	88	.375	.591	.439	29.359	29.296	29.290	29.315
T 26......	57	52	50	53	87	100	100	.407	.388	.361	29.264	29.260	29.273	29.266
F 27......	47	50	49	$48\frac{2}{3}$	100	100	100	.323	.361	.348	29.251	29.163	29.087	29.167
S 28......	49	48	44	47	100	100	92	.348	.335	.265	28.978	28.975	29.090	29.014
S 29......	40	52	38	$43\frac{1}{3}$	91	86	100	.225	.334	.229	29.268	29.283	29.346	29.299
M 30......	31	57	40	$42\frac{2}{3}$	89	81	100	.155	.378	.248	29.390	29.315	29.270	29.325
T 31......	33	59	38	$43\frac{1}{3}$	89	82	100	.168	.410	.229	29.158	29.026	28.997	29.060
Sums......	......	......	......	......	......	......	......	......	......	......	....	....	....	......
Means......	......	......	......	54.10	88	78.3	92.7	.317	.471	.354	....	....	....	29.237
Average..	......	......	......	......		86.3			.447		....	....	....	....

OCTOBER, 1899, AT AGRICULTURAL COLLEGE, LANSING, MICHIGAN.

Clouds.						Winds.						Registering thermom'r.		Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
....	....	....	....	....	....	e	....	s e	3	s e	2	52	32	....	....	......	......
90	Al Cu.	....	....	....	....	s e	7	s e	8	s e	6	59	41	....	....	......	......
30	Cir.	....	....	30	Cir.	s	5	s w	6	s w	1	74	43	....	....	......	......
80	Cir. St.	70	Cir.	100	Cir. St.	n e	1	n	2	n	0	63	32	....	....	......	......
....	....	90	St.	....	....	*	1	w	3	w	....	63	34	....	....	......	......
....	....	....	....	....	....	n e	....	e	4	e	0	63	30	....	....	......	......
10	Cir.	....	....	....	....	e	3	e	3	e	0	64	33	....	....	......	......
50	Cir.	90	Cir. St.	50	Cu.	....	1	e	2	s e	9	59	31	....	....	......	......
60	Al. Cu.	70	Cir.	....	....	s	7	s w	....	s	....	69	40	....	....	......	......
40	Cir.	90	Cu. St.	80	Cu. St.	s	....	s	11	s	10	79	58	Night.	....	†	......
100	St.	100	St.	100	St.	s	6	s	5	s	4	64	56	8 a. m.	10 a. m.	†	......
....	....	70	Cu. St.	....	....	s	4	s	7	s	....	74	54	....	....	......	......
40	Cu.	10	Cu.	10	Cir.	s	....	s	10	s	4	83	69	....	....	......	......
90	Cir.	100	Cu. St.	10	Cu.	s e	3	n e	4	n e	1	71	50	....	....	......	......
20	Cir.	20	Cu.	....	....	e	5	s	9	s	6	81	57	....	....	......	......
....	....	90	Cir.	100	St.	s	10	s	17	n w	2	83	44	7 p. m.	....	......	......
100	Nim.	100	St.	....	....	n w	1	n	1	e	0	50	33	....	9 a. m.	.92	......
....	....	....	....	....	....	s	4	s w	8	s	1	59	34	....	....	......	......
90	Cu. St.	100	Nim.	100	St.	e	2	n e	2	n e	3	48	30	11 a. m.	....	......	......
....	....	....	....	10	Cir.	e	2	e	2	e	1	52	31	....	Night.	.12	......
....	....	10	Cir.	20	Cir.	s e	7	s e	....	s e	....	56	36	....	....	......	......
90	Cu. St.	10	Cu.	....	....	s e	....	s	....	s w	....	71	47	....	....	......	......
90	Cir. Cu.	....	....	....	....	s w	....	s w	11	s w	8	80	57	....	....	......	......
....	....	....	....	....	....	s w	11	s w	11	s w	7	76	51	....	....	......	......
10	Cir.	25	Cir. St.	....	....	s w	9	s w	14	s w	7	75	51	....	....	......	......
60	Cir. St.	100	Nim.	100	Nim.	s w	4	n e	3	n e	4	62	46	10 a. m.	....	......	......
100	St.	100	Nim.	100	Nim.	e	3	e	3	n e	6	51	46	9 a. m.	6 a. m.	.60	......
100	Nim.	100	Nim.	100	St.	n e	3	n e	5	n	4	54	38	....	7 p. m.	1.04	......
....	....	....	....	....	....	n w	5	n w	5	w	0	54	28	....	....	......	......
....	....	....	....	....	....	s	....	s	3	e	0	58	29	....	....	......	......
10	Cir.	80	Cir. St.	....	....	e	0	e	2	e	0	60	31	....	....	......	......
....	....	....	....	....	....	....	....	....	....	....	....	......	......	....	....	2.68	......
40.6	....	46.0	....	29.4	....	....	....	....	....	....	....	64.7	41.7	....	....	......	......
38.7						....	....	....	....	....	....	......	......	....	....	......	......

* Calm. † Trace.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.				Relative humidity, or per cent of saturation.			Pressure of vapor, in inches.			Barometer reduced to freezing point.			
	7 A. M.	2 P. M.	9 P. M.	Daily mean.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Mean.
W 1......	39	43	33	38⅓	91	100	80	.216	.278	.150	28.999	29.074	29.250	29.108
T 2......	33	37	32	34	70	81	100	.131	.178	.181	29.384	29.349	29.332	29.355
F 3......	34	33	32	33	79	100	100	.155	.188	.181	29.200	29.133	29.026	29.116
S 4......	30	44	32	35⅓	89	84	89	.118	.241	.162	29.123	29.058	29.136	29.106
S 5......	34	40	31	35	79	82	89	.155	.203	.155	29.305	29.338	29.446	29.363
M 6......	26	46	30	34	87	84	89	.123	.262	.148	29.530	29.524	29.519	29.524
T 7......	30	51	33	38	89	86	100	.148	.321	.188	29.512	29.444	29.432	29.463
W 8......	31	50	31	37⅓	89	85	100	.155	.309	.174	29.378	29.270	29.268	29.305
T 9......	33	68	33	44⅔	89	85	100	.168	.577	.188	29.150	29.051	29.022	29.074
F 10......	39	44	40	41	91	92	100	.216	.265	.248	29.088	29.011	28.960	29.030
S 11......	38	39	33	36⅔	100	91	100	.229	.216	.188	29.025	29.136	29.292	29.151
S 12......	30	35	31	32	78	90	89	.130	.183	.155	29.438	29.427	29.434	29.433
M 13......	34	47	39	40	89	85	91	.175	.273	.216	29.429	29.362	29.315	29.369
T 14......	41	45	43	43	100	92	92	.257	.275	.254	29.105	29.099	29.086	29.097
W 15......	43	48	42	44⅓	100	92	83	.278	.310	.222	29.041	29.077	29.235	29.118
T 16......	33	53	44	43⅓	80	73	84	.162	.295	.241	29.340	29.243	29.231	29.271
F 17......	43	57	53	51	92	81	93	.254	.378	.375	29.158	29.049	29 045	29.084
S 18......	54	58	55	55⅔	93	94	94	.390	.452	.405	29.092	29.098	29.134	29.108
S 19......	41	57	34	44	91	87	100	.235	.407	.196	29.167	29.153	29.180	29.167
M 20......	30	52	39	40⅓	89	86	100	.148	.334	.238	29.205	29.177	29.165	29.182
T 21......	37	60	39	45⅓	90	71	92	.199	.367	.322	29.097	28.960	28.936	28.998
W 22......	47	44	39	43⅓	100	92	90	.323	.265	.199	28.945	28.944	28.986	28.958
T 23......	37	41	37	38⅓	90	82	90	.199	.212	.199	29.077	29.149	29.270	29.165
F 24......	36	39	36	37	90	73	100	.191	.173	.212	29.346	29.310	29.310	29.322
S 25......	36	42	29	35⅔	90	83	100	.191	.222	.160	29.306	29.264	29.254	29.275
S 26......	29	44	34	35⅔	100	84	89	.160	.241	.175	29.231	29.138	29.108	29.159
M 27......	31	45	37	37⅔	89	92	100	.155	.275	.221	29.051	28.968	28.954	28.991
T 28......	35	46	40	40⅓	100	92	91	.204	.286	.225	28.836	28.779	28.821	28.812
W 29......	37	46	40	41	90	84	100	.199	.262	.248	28.775	28.596	28.556	28.642
T 30......	42	49	46	45⅔	83	85	84	.222	.297	.262	28.692	28.708	28.616	28.672
Sums......														
Means......				40.04	86.2	86.3	93.6	.197	.285	.216				29.147
Average......						88.7			.233					

NOVEMBER, 1899, AT AGRICULTURAL COLLEGE, LANSING, MICHIGAN.

Clouds. 7 A. M. Per cent of cloud.	Clouds. 7 A. M. Kind.	Clouds. 2 P. M. Per cent of cloud.	Clouds. 2 P. M. Kind.	Clouds. 9 P. M. Per cent of cloud.	Clouds. 9 P. M. Kind.	Winds. 7 A. M. Direction.	Winds. 7 A. M. Force.	Winds. 2 P. M. Direction.	Winds. 2 P. M. Force.	Winds. 9 P. M. Direction.	Winds. 9 P. M. Force.	Registering thermom'r. Maximum.	Registering thermom'r. Minimum.	Rain and snow. Beginning, rain or snow.	Rain and snow. Ending, rain or snow.	Rain and snow. Inches of rain or melted snow.	Rain and snow. Depth of snow, inches.
100	St.	100	Nim.	100	Nim.	n e	3	n e	5	n	5	42	30	*	....	.03	...
90	Cir. Cu.	100	Cu. St.	100	St.	n e	6	n e	6	n e	1	39	30	†	....	.....	....
100	St.	100	Nim.	100	Nim.	n e	5	n e	4	n e	4	35	28	‡	....	.98	3
....	......	30	Cir.	....	....	s w	1	s w	10	s w	1	45	26	....	....	.....	...
10	Cu. St.	70	Cir. Cu.	....	....	n w	3	n w	6	n w	0	43	23	....	....	.....	......
....	......	....	......	....	....	s w	1	s w	4	s w	0	46	26	....	....	.....	...
20	Cir.	80	Cir.	30	Cir.	s w	1	s w	4	s w	1	52	25	....	....	.....	......
60	Cir.	50	Cir.	....	....	s w	0	s w	3	s w	0	51	29	....	....	.....	...
20	Cir.	30	Cir. Cu.	20	Cir. Cu.	s w	6	s w	12	s w	2	59	31	....	....	.....	......
100	St.	100	Nim.	100	Nim.	e	1	e	1	n e	3	47	37	§	....	.23	......
100	St.	100	Cu. St.	100	St.	n	3	n	4	n	3	40	28	....	....	.....	...
50	Al. Cu.	30	Cir. Cu.	100	St.	n	2	s	1	s e	0	38	29	....	....	.....	......
100	St.	30	Cir.	100	Cir. St.	s e	3	s w	5	s e	8	48	33	....	....	.....	......
100	Nim.	100	St.	100	St.	e	4	e	4	s e	0	43	40	‖	....	.46	......
100	Nim.	100	St.	90	Cir. Cu.	s w	4	s w	8	s	1	48	32	7 a. m.	10 a. m.	¶	......
10	Cir.	....	....	70	Cir.	s e	0	s e	10	s e	10	53	32	....	....	.....	......
60	Cir.	100	St.	30	Cir.	s	8	s	7	s w	6	57	42	....	....	.....	......
90	Cir.	60	Cir.	100	St.	s w	5	s w	....	s w	....	60	38	....	....	.....	......
60	Cir.	50	Cir.	....	....	s w	....	w	4	s	0	58	27	....	....	.....	......
....	....	....	....	....	....	e	....	s	4	s	3	53	29	....	....	.....	......
30	Cir.	90	Al. Cu.	....	....	s	3	s w	5	s	2	60	36	....	....	.....	......
100	St.	90	St.	....	....	n e	4	n e	4	n e	5	47	35	7:30 a m	10 a. m.	¶	.....
100	St.	100	Cu. St.	100	St.	n e	4	n e	5	n e	2	42	35	....	....	.....	.....
100	St.	100	St.	100	St.	n e	1	n w	1	n w	0	40	35	....	....	.....	.....
100	Cir St.	80	Cu. St.	....	....	e	0	e	1	n w	0	42	28	....	....	.....	.....
20	Cir.	....	....	70	Cu.	n w	....	n w	4	n w	2	44	29	....	....	.....	......
100	St.	30	Cir.	....	....	w	1	s w	5	s w	4	46	30	Fog.	....	.....	......
30	Cir.	90	Cir. St.	100	St.	s w	6	w	6	s w	3	48	34	2:30 pm	5 p. m.	.02	0
100	St.	100	St.	60	Cu. St.	s w	5	s w	12	s w	11	46	39	....	....	.....	......
90	Cu.	90	Cir. St.	90	Cir.	s w	1	s e	4	s e	7	50	41	....	....	.....	......
....	......	....	......	....	......	....	....	....	....	....	....	....	......	....	....	1.72	3.00
64.7	......	66.0	....	55.3	....	....	....	....	....	....	....	47.5	31.8	....	....	......	......
62.0						....	....	....	....	....	....	....	......	....	....	....	......

* Snow 2 p. m.; in night.
‡ Rain and snow, 8 a. m.; in night.
‖ Rain and snow in night; 11 a. m.

† Rain and snow 5 p. m.; in night.
§ Rain and snow, 11:30 p. m.; in night.
¶ Trace.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air. 7 A. M.	2 P. M.	9 P. M.	Daily mean.	Relative humidity, or per cent of saturation. 7 A. M.	2 P. M.	9 P. M.	Pressure of vapor, in inches. 7 A. M.	2 P. M.	9 P. M.	Barometer reduced to freezing point. 7 A. M.	2 P. M.	9 P. M.	Mean.
F 1......	45	42	33	40	100	71	89	.300	.199	.168	28.606	28.605	28.728	28.646
S 2......	37	40	31	36	90	91	89	.199	.225	.155	28.637	28.681	28.815	28.711
S 3......	31	35	31	32⅓	89	80	89	.155	.162	.155	28.860	28.842	28.869	28.857
M 4......	23	27	22	24	100	75	86	.123	.111	.101	28.887	28.938	29.070	28.965
T 5......	16	19	23	19⅓	100	84	100	.090	.087	.123	29.017	28.863	28.939	28.939
W 6......	19	26	20	21⅔	84	87	85	.087	.125	.091	29.223	29.333	29.418	29.325
T 7......	29	34	33	32	88	100	89	.142	.196	.168	29.213	29.103	29.255	29.190
F 8......	31	45	29	35	89	84	100	.155	.251	.160	29.283	29.280	29.314	29.292
S 9......	30	43	39	37⅓	89	75	100	.148	.209	.238	29.265	29.182	29.085	29.177
S 10......	44	48	48	46⅔	92	100	100	.265	.335	.335	29.032	29.034	29.068	29.045
M 11......	50	55	56	53⅔	100	100	100	.361	.433	.449	28.766	28.685	28.435	28.629
T 12......	34	33	31	32⅔	89	100	100	.175	.188	.174	28.369	28.565	28.800	28.578
W 13......	25	26	25	25⅓	100	87	87	.135	.123	.117	29.069	29.218	29.315	29.201
T 14......	23	25	20	22⅔	100	100	100	.123	.135	.108	29.306	29.225	29.230	29.254
F 15......	16	25	21	20⅔	100	87	86	.090	.117	.101	29.399	29.491	29.542	29.477
S 16......	11	21	18	16⅔	100	100	100	.071	.113	.098	29.536	29.429	29.366	29.444
S 17......	21	35	29	28⅓	100	80	100	.113	.162	.160	29.214	29.216	29.295	29.242
M 18......	37	39	46	40⅔	90	100	100	.199	.238	.311	29.271	29.176	29.131	29.193
T 19......	31	33	28	30⅔	89	80	88	.155	.150	.135	29.398	29.464	29.541	29.468
W 20......	24	39	32	31⅔	100	63	89	.129	.152	.162	29.503	29.398	29.332	29.411
T 21......	29	43	29	33⅔	88	83	100	.142	.231	.160	29.310	29.306	29.325	29.314
F 22......	24	44	28	32	100	76	100	.129	.218	.153	29.330	29.281	29.210	29.274
S 23......	29	39	29	32⅓	100	91	61	.160	.216	.120	28.991	28.789	28.660	28.813
S 24......	30	25	16	23⅔	89	87	100	.148	.117	.090	28.544	28.566	28.644	28.585
M 25......	12	14	12	12⅔	100	100	100	.075	.082	.075	28.595	28.596	28.739	28.643
T 26......	12	18	15	15	100	84	100	.075	.082	.086	28.881	28.941	29.025	28.949
W 27......	15	18	13	15⅓	100	100	100	.086	.098	.078	29.122	29.086	29.074	29.094
T 28......	16	17	6	13	100	100	100	.090	.094	.057	29.189	29.180	29.213	29.194
F 29......	6	11	2	6⅓	100	100	100	.057	.071	.048	29.254	29.218	29.220	29.231
S 30......	—4	8	6	3⅓	100	100	100	.036	.062	.057	29.122	29.044	28.919	29.028
S 31......	3	10	7	6⅔	100	100	100	.038	.068	.060	28.712	28.650	28.659	28.674
Sums......	......	......	......	821⅓	......	......	......	......	......	......	....	....	....	....
Means......	......	......	......	26.49	95.7	89.7	94.8	.138	.163	.145	....	....	....	29.059
Average......	......	......	......	......		93.1			.149		....	....	....	....

DECEMBER, 1889, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Registering thermom'r.		Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.							
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Maximum.	Minimum.	Beginning, rain or snow.	Ending, rain or Snow.	Inches of rain or melted snow.	Depth of snow, inches.
100	Nim.	30	Cu.	60	Cu.	s w	9	w	13	w	2	45	31	7 a. m.	9 a. m.	*	
100	Cu. St.	100	Cu. St.	100	St.	s w	8	n w	3	n w	....	42	29	....	....	......	......
100	St.	60	Al. Cu.	70	St.	n w	....	n w	3	n w	1	35	23	†	....	......	......
70	Cu. St.	30	Cir.	100	St.	n	1	n	6	n w	4	27	16	9 p. m.	....	.02	.20
100	St.	100	St.	80	Cu. St.	s w	20	s w	16	s w	5	24	13	....	†	.02	.20
60	Cir.	20	Cir.	....	....	w	3	w	....	s w	6	29	19	....	....	......	......
100	Cir. St.	100	Nim.	50	Cir.	s	11	w	9	w	4	37	26	10 a. m.	3:30 pm	.03	......
10	Cir.	10	Cir.	....	....	s w	6	s w	5	s w	1	45	26	....	....	......	......
20	Cir.	100	Cir. St.	100	Nim.	s e	3	s e	7	s e	11	44	28	8:30 pm	†	.06	......
100	St.	100	St.	100	St.	s	8	s	8	s	6	49	41	....	....	......	......
100	Nim.	100	Nim.	100	Nim.	s	13	s	12	s	13	56	43	†	†	.86	......
90	Cir. St.	100	St.	100	St.	s	16	s w	....	s w	....	34	24	‡7:30am	†	.03	.30
90	St.	80	Cu.	100	Cu. St.	w	....	w	....	w	....	28	22	‡8 a. m.	11 a. m.	.02	.20
100	St.	70	Cu. St.	30	Cir.	n e	4	n e	3	n	2	25	10	8 a. m.	7 p. m.	.20	2
100	St.	20	Cir.	50	Cir.	s w	4	s w	....	s w	2	25	10	....	....	......	......
40	Cir.	10	Cir.	30	Cir.	w	....	s w	6	s e	8	23	11	....	....	......	......
20	Cir.	....	....	20	Cir.	s	3	s w	6	s w	3	37	21	....	....	......	......
100	St.	100	Nim.	100	Nim.	s	5	s	6	w	10	46	30	1 p. m.	†	.16	......
30	Cir.	10	Cir.	....	....	n w	9	n w	10	w	9	33	24	....	....	......	......
....	....	....	....	....	....	w	4	s w	11	s w	12	40	24	....	....	......	......
....	....	....	....	....	....	s w	9	s w	8	s w	2	44	24	....	....	......	......
....	....	10	Cir.	....	....	s w	3	s w	7	s w	3	45	24	....	....	......	......
20	Cir.	100	St.	100	Cir.	s e	3	s e	4	s w	2	40	27	2:30 pm	6 p. m.	.04	......
80	Cir.	100	Cir.	100	Cir.	w	16	w	....	w	....	30	10	§	....	......	......
50	Cir.	70	Cir.	100	Cir.	w	....	w	9	w	5	15	10	¶	....	......	......
80	Cir.	50	Cir.	80	Cir.	w	8	w	9	w	8	14	11	....	....	......	......
90	Cu.	50	Cu.	....	....	s w	9	w	11	w	9	19	12	....	....	......	......
70	Cir. Cu.	50	Cu.	....	....	w	7	w	11	w	5	19	4	¶	....	.02	.20
....	....	70	Cu.	....	....	w	6	n w	9	n w	3	13	—7	¶	....	......	......
20	Cir.	10	Cir.	80	Cir.	n w	....	s w	7	s w	4	8	—4	4 p. m.	†	*	......
90	St.	80	Cir. St.	100	St.	s w	14	s w	14	s w	3	11	—6	5 p. m.	†	.05	.50
....	....	....	....	....	....	....	....	....	....	....	....	......	......	....	....	1.51	3.60
62.3	....	55.8	....	56.4	....	....	....	....	....	....	....	31.7	18.6	....	....	......	......
58.2						....	....	....	....	....	....	......	......	....	....	......	......

* Trace. † In Night. ‡ Snow. § Snow flurries during day. ¶ Snow flurries.

BULLETINS

OF THE

AGRICULTURAL COLLEGE EXPERIMENT STATION

ISSUED DURING THE

YEAR ENDING JUNE 30, 1900

EXPERIMENT STATION BULLETINS.

SOME INSECTS OF THE YEAR 1898.

BY RUFUS H. PETTIT, ASSISTANT ENTOMOLOGIST.

Bulletin 175.—Entomological Department.

INTRODUCTORY.

The insects treated in this bulletin are only a small fraction of those which have come under our notice during the year of 1898, and it should be stated further that this report relates only to the summer of that year.

Notes are given on about twenty species of insects, a list of which will be found on the following page. Bulletin No. 160, published in June of last year, covered twenty-eight species, all different from those here given. A subsequent bulletin probably will take up some other insects which have been troublesome, and thus it is hoped to cover by degrees all the more destructive or otherwise interesting insects of the State.

It may be well to repeat here the advice given to correspondents last year, which is as follows:

Whenever information is wanted in regard to any insect, insect work, or insecticide, the proper person at the College to address is not anyone whom you may know personally, or by name or reputation, but simply "The Entomologist of the Experiment Station," Agricultural College, Mich. Inquiries addressed in this way are sure to reach this department directly and to receive attention at the earliest possible moment. If addressed otherwise, delay may occur for various reasons, and in some cases the loss of a single day might endanger an entire crop.

It is well to remember that the most careful description of an insect is seldom as good as the insect itself, while in most cases a mere fragment of the actual insect is better than a page or two of description. Therefore in writing for information about any insect always enclose a specimen if possible, no matter how common or well known you may believe it to be; and if no sample of the insect can be found, send a sample of its work. In sending specimens by mail, they should be sent in glass or tin if possible, and with some of their natural food if alive. Leaves and fruits wilt rapidly if enclosed in wood or pasteboard boxes, and are also very likely to be crushed or broken in transmission. Small tin boxes of any shape may be used, and it is well to put a slip of paper with the address of the sender inside the box, in case the outer wrapper should be torn off or defaced. If a letter is enclosed with the specimens, the whole package is subject to letter postage: if the two are sent separately, they should

be addressed exactly alike, and the package of specimens should be marked with the sender's name and address *invariably*. Failure to use this simple rule has lead to more disappointment and trouble than would be supposed. Rarely does a week pass when we do not receive specimens without letters, or letters without specimens which are said to have been sent: and it is no uncommon thing during the height of the season to receive half a dozen packages by the same mail and to be unable to decide which are the insects referred to in letters received at the same time. Always send insects alive if possible, but send in strong, tight boxes—insects need no air-holes whatever. Never try to kill scale insects or others by dipping in kerosene or other insecticide before mailing. Always state definitely what harm, if any, the insect is supposed to be doing, and whether it is abundant or scarce.

Sixteen of the twenty illustrations for this bulletin were prepared expressly for it by Mr. R. H. Pettit, the Assistant Entomologist of the Station, and their accuracy and beauty leaves little to be desired. The remaining cuts have been taken from trustworthy sources and proper credit given. The bulk of the text has been written by Mr. Pettit, and it is believed that the whole forms a valuable addition to our knowledge of the insects of the State.

We should be glad to receive further notes on any of the species mentioned, and particularly personal experiments with any of the injurious forms and their supposed remedies.

WALTER B. BARROWS,
Consulting Zoologist.

CONTENTS.

1. AMERICAN LOCUST.

(*Schistocerca americana.*)

One of the most beautiful of our locusts or grasshoppers is the American Locust. This insect, while it is a serious pest in the central and southern states, has been reported, probably for the first time, in Michigan during the past summer. Specimens were sent here from three widely different parts of the State—Springville, Lenawee county; Frankfort, Benzie county, and Berrien Springs, Berrien county. They were not said to be injurious in these places and only occasionally seen.

While this insect has never been known to be injurious as far north as this, its large size makes it a formidable enemy when it comes in large swarms, as it does farther south. In places where it abounds it is fought in the same way as we fight our grasshoppers—with poisoned baits, hopperdozers, etc.

2. ONION THRIPS.

(*Thrips tabaci* Lindeman.)

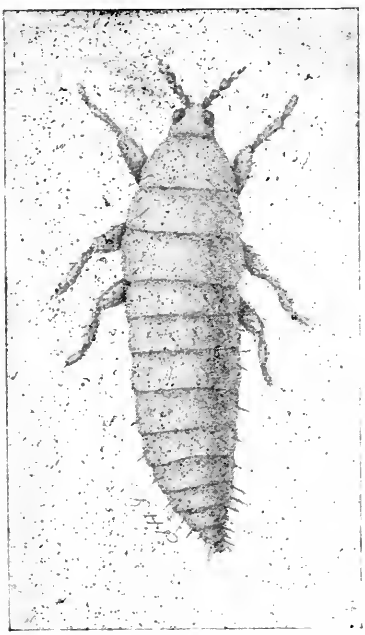

Fig. 1. Onion Thrips. *Thrips tabaci*, immature. (Original.)

Toward the latter part of September complaints were made that a louse or some minute insect was attacking onion tops in the vicinity of Chelsea, Michigan. Specimens of such onion tops were found to be infested by a species of thrips (*Thrips tabaci*), the great majority of the insects being in the wingless or immature stage. They are very small, green, inconspicuous creatures and seem to prefer the auxillary region where two leaves approach each other. The effect of their depredations is noticeable at some distance. The tops become stunted and sickly, turning whitish wherever the insects congregate. The leaves sometimes decay if the weather is wet, and the keeping quality of the onions is said to be impaired by the work of these pests.

On examining some of the plants on the College farm, they were found to be infested.

The immature insects, which are far more plentiful than the adult, are about 1-24 of an inch in length and yellowish green in color. They are so small as to be almost imperceptible to the unaided eye, but a careful examination reveals them in close proximity to the white spots on the onion tops. They appear, when greatly magnified, somewhat as represented by Fig. 1. The body is long and tapering, with six legs near the anterior end: the antennae or feelers are six-jointed, and the feet are like

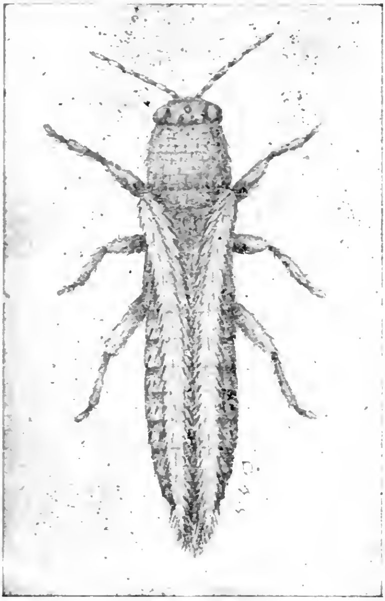

Fig. 2. Onion Thrips, *Thrips tabaci*, mature. (Original.)

those of all true thrips, destitute of claws.

The adult winged insect is represented by Fig. 2, shown at rest, with the wings closed, as this is the position in which it is most often seen. The general color is dirty yellow with dusky markings. The feelers are seven jointed, and the size slightly larger than the immature stage. The extremely narrow wings are fringed with long hairs on each side, giving them a feathery appearance.

NATURAL ENEMIES.

Gregarinida. There are several insects that feed on the tobacco thrips, reducing its ravages, also a parasite, not an insect, that will probably prove to be a gregarinid, was found in many of the dead bodies of this pest. It was noticed that in the breeding-cages, which were rather moist, many of the insects were dying and turning black; on examining one of them in water under a high power of the microscope it was found to be packed completely full of small spherical bodies (Fig. 3). These little bodies, 16 to 20 microns or one twelve hundred and fiftieth of an inch in size, had entirely exhausted the body contents of the insects, leaving nothing else in them: they were dark purplish black in color with eccentric nuclei. One of these spheres, on being crushed, let out about a dozen smaller elongated bodies that answered very well to the description of pseudonavicelli, which are usually contained in the spores of gregarinids.

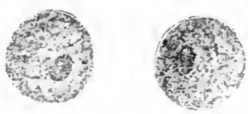

Fig. 3. Gregarinida in Onion Thrips. (Original.)

The disease caused by these parasites seemed to thrive best in moist atmosphere, as in the cages. Owing to the lateness of the season, it was not possible to observe the transformations of this interesting organism and thereby to place it accurately.

In a bulletin of recent date by Prof. Quaintance of the Florida Experiment Station, the life-history of the insect is described. According to this bulletin, the average length of time required for the adult to be developed from the egg is sixteen days, thus allowing many generations to mature in a single season. However, it is quite probable that in Michigan the time required is somewhat longer because of the colder climate. In Russia, where the insect first appeared on tobacco, there are said to be three generations during the year.

A description of this insect and of its work, as well as a résumé of the recent literature on the subject, is given by Mr. Thomas Pergande of the United States Department of Agriculture at Washington.*

In this account a large number of plants are said to be attacked: among others cabbage, cauliflower, squash, turnip, catnip, sweet-clover, and cultivated flowers. It is a serious tobacco pest in Russia.

* Insect Life, Vol. vii, pp. 392-5.

REMEDIES.

Thrips in general are classed with the sucking insects, and to kill them we must resort to contact insecticides. Kerosene emulsion, used at the rate of one part of the emulsion (Hubbard formula) to ten of water, has been found to destroy them. Drenchings of cold water are said to be useful on a small scale, for all the members of this family thrive best in a dry atmosphere and soon succumb to continued moisture. Whale-oil soap, used at the rate of one pound to four gallons of water, will no doubt prove a very good remedy.

3. THE RING-LEGGED TREE BUG.

(*Brochymena annulata* Fab.)

Mr. John E. Hoag of Cannonsburg, Kent county, Michigan, reports the finding of numbers of these interesting bugs (Fig. 4) in his peach and plum orchard, and while no complaint of serious injury is made, the occurrence is of interest because injury has been done by this insect in other states. It has been reported two or three times as working on apple trees, but never before in Michigan, so far as is known to the writer. The insect is noticed here not because it is considered dangerous, but in order to prevent anxiety if it should appear from time to time. It will no doubt readily succumb to kerosene-emulsion or whale-oil soap in the usual proportions.

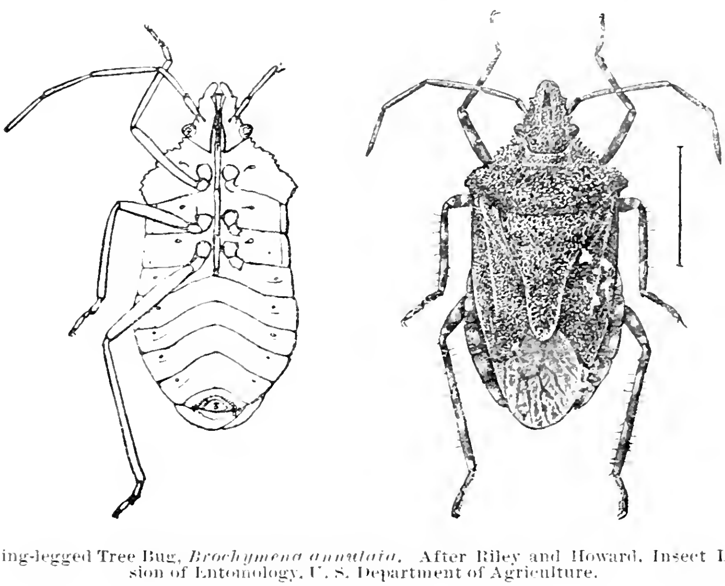

Fig. 4. Ring-legged Tree Bug, *Brochymena annulata*. After Riley and Howard, Insect Life, Division of Entomology, U. S. Department of Agriculture.

4. THE STRAWBERRY LEAF-ROLLER.

(Phoxopteris comptana.)

One of the most troublesome insects of the season of 1898 was the strawberry leaf-roller (*Phoxopteris comptana*).* From all over the southern part of the State, wherever strawberries were grown, came complaints. Specimens of the curled leaves were sent us from Three Rivers and the adult moth was bred from them. The caterpillars are small yellowish or green "worms," which feed on the leaves and cause them to curl up tightly into little clumps, which are then bound together with a silken web. Often the enclosed places are partially lined with the same material, making a nest. The caterpillars or larvae may be found usually by pulling apart some of the curled leaves. They vary in color from pale yellowish to quite a decided green, and

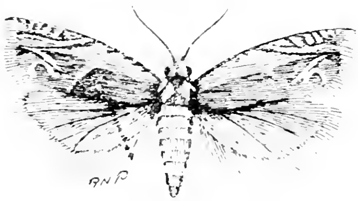

Fig. 5. Strawberry Leaf-roller, *Phoxopteris comptana*. (Original.)

when full grown are about one-third of an inch in length, slender and gently tapering. The adult winged form, not seen so often, is a very small and delicate moth, reddish brown and dusky in color, with black and white markings and about one-fourth of an inch in length, while the extended wings measure a little less than half an inch.

This dainty little moth comes forth early in the spring and lays its eggs for the first brood on the young strawberry leaves. These eggs hatch and the "worms" or caterpillars appear in June. If numerous, they devastate the strawberry beds and then, becoming adults, lay more eggs in September. These eggs hatch and the young "worms" have just about time enough to become full-grown and go into the ground for the winter.

REMEDIES.

After the first year of course no poison should be used on the plants before the berries are gathered, but directly after gathering the berries, or during the first year before the plants bear, the plants should be cut off close with a mowing machine and burned. The field may then be sprayed with Paris green and lime, which will serve to kill numbers of the full-grown worms in the leaves and also to poison what young larvae may come from the eggs already laid. The spray, of course, should be repeated as long as any caterpillars remain. This method should prove of great benefit and the regular rotation of crops will also be found useful. In some instances the fields have been burned over, with good results, instead of cutting with a machine. This was done about the time that the second brood of worms appeared.

The worms are easily killed with a spray of Paris green and lime, but as this must not be used before the wheat is harvested, some other remedy is often required, and this is found in kerosene emulsion. Obviously this must not be sprayed on ripening fruit, but the spray must be applied in time to allow the oil to evaporate before the fruit is picked. If this is done as soon as the worms appear and repeated until just before picking time it will prove a comparatively easy task to keep the worms in check. It must be remembered, however, that kerosene emulsion requires much more careful application than the arsenites, for each worm must be hit to be killed. After the crop is harvested the plants should be mowed and treated with Paris green as previously advised to guard against the appearance of the pest next season.

* The hymenopterous parasite Temelucha cooki and perilampus cyaneus were bred from this moth. They were determined by Mr. Wm. Ashmead of the Department of Agriculture, Washington D. C., through the kindness of Dr. L. O. Howard.

5. A NEW PEACH-WORM.

Depressaria persicaeella Murt. sp. nov.

A number of worms working in peach leaves were received from Mr. T. D. Atkinson of Holland, Michigan, on September 17 (Fig. 6). They were lepidopterous larvae,

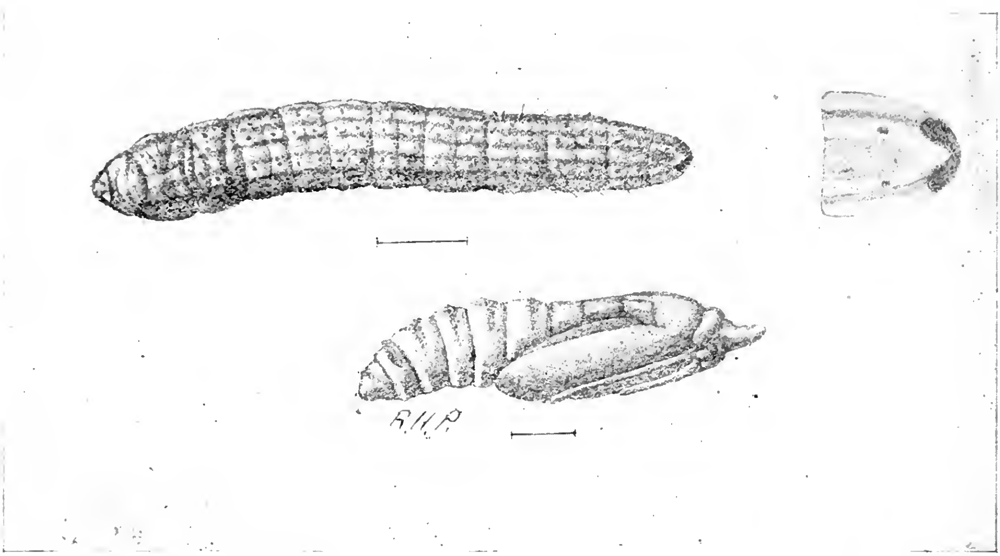

Fig. 6. Peach Leaf-binder, *Depressaria persicaella* Murt. (Original.)

and were said to be very troublesome. The same species was received on July 3, 1899, from Monroe, Michigan. One or two complaints were made from other places though no specimens were sent.

The larvae are very restive, wriggling violently when disturbed. They bind together the leaves of the peach with fine white silk, forming nests of loosely bound leaves, in which they live and where they change to pupae. The finding of the larvae on July 3d, and also on September 17th, would seem a good indication that the insect is two-brooded.

Specimens of the larvae from Holland were placed in suitable cages and the moth, a small, nearly black insect, spreading about five-eighths of an inch, was obtained the following spring. The adults commenced to appear about April 14th, and continued to emerge till the middle of May. Of course this is much earlier than would happen if the insects were out of doors.

Specimens were sent to Miss Mary E. Murtfeldt, of Kirkwood, Mo., who has kindly drawn up the following description of the adult insect:

Depressaria persicaella, Murt. sp. nov.

"Antennae dark fuscous, indistinctly pectinate and annulate on the under side with pale buff. Palpi long, exceeding the vertex, basal joint short, pale; second joint one-third longer than apical; brush quite dense, dark fuscous overlaid with buff or cream colored scales palest on inner surface; apical joint dark, very slender with extreme tip cream white, most distinctly so in the male. Tongue long, sparsely scaled. Vertex dark brown, face cream white.

"Thorax and tegulae purplish brown.

"Forewings almost black with rich purplish gloss sparsely sprinkled with white scales. On the costa back of the apex is a small irregularly triangular cream white spot and a few scattered scales of the same color form an obscure outer border. In the cell near the upper margin are two somewhat indefinite, cream-colored dots in line with a third below and slightly back of the one nearest the base. Cilia concolorous with the general surface, shading outwardly to gray. Lower wings shining, silky cinerous almost silvery. Alar expanse from 16 to 17 millimeters. Abdomen pale brown, terminal segment banded with buff at posterior edge; lateral tufts buff and conspicuous; under surface speckled with brown and cream; anal tuft pale reddish brown.

"Legs brown, annulate with cream white at the joints and middle of tibiae."

The following description of the larva was written by the author from the living insect:

Description of Larva.—The larva, when full grown, is three-eighths of an inch in length and quite slender. Its color is dirty yellowish-white, with back and sides marked by six reddish-brown longitudinal stripes, all of which extend the entire length from the thoracic shield to the caudal extremity except the pair on the dorsum, which unite on the last segment and terminate there. Last segment bordered caudally with fuscous and base of anal pro-legs colored the same. Venter marked along the middle with a stripe like those on dorsum and sides, which are about equidistant from each other and of about the same width as the spaces between them, color reddish-brown. Some of the spaces (yellowish-white) have dark points in them. Head and thoracic shield yellowish-brown, feet fuscous and dirty yellow. Four pairs of pro-legs beside anal pair which are of the same color as the ground color of the body. Base of anal pair black.

REMEDIES.

The two methods which probably will prove of most use in fighting this trouble are cutting out, and spraying with Paris green. The nests become quite conspicuous and in many instances can be cut out and burned without doing too much harm to the tree. A spray of Paris green will kill the worms if applied so as to penetrate the nests. Of course lime must be used with the poison, and neither peach trees nor any other fruit trees should be sprayed with Paris green after the fruit becomes of any size.

6. FOREST TENT-CATERPILLAR.

(*Clisiocampa disstria* Hub.)

An insect very similar to our orchard tent-caterpillar, but differing somewhat in appearance and habits, is the tent-caterpillar of the forest. An outbreak of this insect was the cause of some damage in Kalkaska and Antrim counties in the early summer of 1898. A belt of land about 30 miles long and nearly as broad, extending across both counties, was infested, the caterpillars appearing in such numbers as actually to stop trains. We are indebted to Mr. Skeels, then Assistant Secretary of the College, for specimens of the insects, as well as the data for this particular infestation.

The eggs of this insect (Fig. 7, d) are laid in masses around the twig or branch of a tree and pass the winter in this form. Early in the spring, about the time the leaves open, or a little before, the eggs hatch and the little caterpillars commence to spin a web, as in the case of the ordinary orchard tent-caterpillar. They enclose the young foliage in a net and a whole family, all that hatch from a single egg-mass, live here together when they are not feeding, at least until the caterpillars attain quite a size. The caterpillars become full grown about the middle of June or the first of July, at which time they come down from the trees and look for suitable places in which to spin their cocoons. It is while searching for such places that they become most noticeable, often traveling along a fence in such great numbers as almost to hide the fence. They gather in great numbers on railroad tracks and, as in the instance mentioned, sometimes impede travel. Their bodies on being crushed make the rails so slippery that the trains come to a standstill when the grade is at all unfavorable.

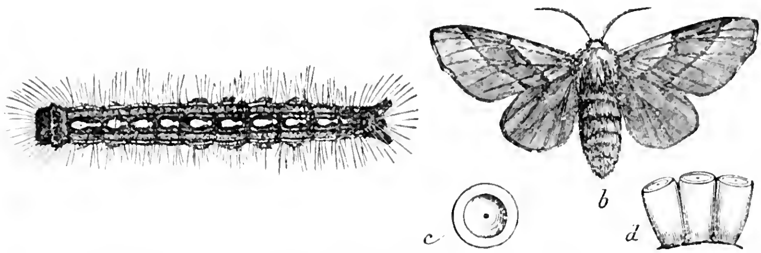

Fig. 7. Forest Tent-Caterpillar, *Clisiocampa disstria*. After Riley, Report on Insects of Missouri. (Third.)

Description of Larva.—The full-grown caterpillar (Fig. 7) is about 1½ inches long with a ground color of pale blue, sprinkled with black points and dots. Along the middle of the back is a row of about ten lozenge shaped white spots and behind each of these spots is a smaller dot of the same color. The entire caterpillar is sparsely covered with soft hairs.

After finding a suitable place, the caterpillar spins up in a loose but strong cocoon, with the silk of which is usually mixed a good leal of yellow powder. The specimens sent to us emerged on July 14 as winged moths (Fig. 7 b); they are dull yellowish or reddish brown in color and when the wings are spread out the female measures about one and three-fourths inches across, the male being a little smaller. Across the front wings extend two oblique dark stripes. After pairing, the eggs are laid and remain for about nine months before hatching. The number of trees attacked by this insect is very large, the list including the oak, walnut, ash, bass-wood, rose, hickory, apple, peach, willow, maple, poplar, plum, cherry, thornapple, beech, and several others. With so large a list of available food-plants, the caterpillars cannot easily be starved out. Luckily they are seldom numerous two years in succession, as their parasites usually keep them in subjection.

REMEDIES.

Of course in the forest spraying would seldom be resorted to, both because of the difficulty of reaching the tree tops and because of the expense. It often happens, however, that the caterpillars work in shade trees, and here they can readily be killed by a spray of Paris green, using one pound of the poison to about 150 gallons of water, and adding one pound of fresh quick-lime to the mixture. Do not spray without the lime, for the mixture recommended would do serious injury to many trees if the lime were omitted.

7. THE SADDLE-BACK CATERPILLAR.

(*Empretia stimulea* Clem.)

From time to time insects are carried far from their natural home and colonies are started which may or may not survive the change, depending on the amount of climatic differences between the two places and on the hardiness of the insects. Two species of insects, transported in this way, have been found in Michigan during the past season, one of which, so far as is known to the writer, has not been reported heretofore. One is the saddle-back caterpillar, *Empretia stimulea*, Clem., and the other the American Locust, *Schistocerca americana*. Both are very destructive insects in their native states. Whether they will remain with us and become serious pests, or die out owing to our more severe winters, or stay with us, but not become numerous enough to be injurious, are questions that it is impossible to answer at present. It would seem, however, that as they are both natives of America, they would have been here before if the climatic conditions were at all favorable to them, the more so as they are found directly south of us in Southern Indiana and Ohio.

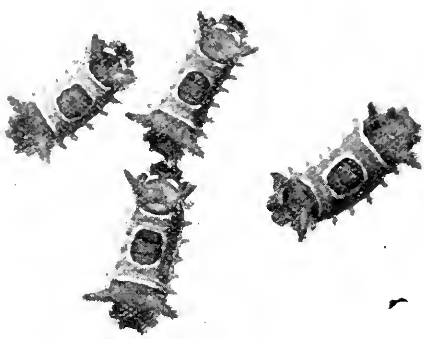

Fig. 8. Saddle-back Caterpillar, *Empretia stimulea*. (Original.)

Fig. 8 represents the larva of the saddle-back caterpillar about natural size. It is apparently footless, progressing like a slug by the undulations of the soft shiny skin of the under surface. The six jointed legs are present, but the soft fleshy pro-legs, that caterpillars usually have, are absent. In general color it is a chocolate brown, having a bright apple-green spot, shaped like a saddle-cloth, on the back. The saddle is represented by a brown oval spot in the center of the green. The four fleshy knobs or conical projections are covered with sharp hairs that easily break off when handled and which convey a poison that acts very much like that of the nettle, producing a sharp stinging or burning pain. The stings from this slug have been known to produce serious results with people of delicate constitution.

The specimens sent us were from Mr. A. Sigler, Adrian, Michigan, and they were on pear. The species also works on cherry and probably on some other fruit-trees, on oak and some other forest-trees, and on rose, grape, corn, Helianthus, currant, sumach and raspberry.

It has been found in the State several times before, once in Lansing by Mr. Victor Lowe of the Geneva Experiment Station, but its occurrence in Michigan is rare.

REMEDIES.

This slug is easily destroyed by the arsenites, Paris green, etc., whenever it becomes necessary. When stung by the hairs, relief can be obtained by bathing the affected part with soda (bicarb.) or with a weak wash of ammonia.

8. THE RESPLENDENT SHIELD-BEARER.

(*Aspidisca splendoriferella* Clem.)*

At the time when the leaves are just about to fall, during the last of September and the first of October, the leaves of the wild cherry, *Prunus serotina*, are sometimes seen to be perforated with regular rows of holes about one-fourth of an inch long. Sometimes as many as a dozen holes are ranged along both sides of the mid-rib of a single leaf. Several trees on and near the College campus were seen to be badly pierced in this way, early in the autumn of 1897. A short time afterward, numbers of little pieces of leaf, corresponding in form to the holes in the cherry leaves, were found attached by fine silken cords to the leaves and branches of a spruce tree stand-

* This species was determined by Miss Mary E. Murtfeldt of Kirkwood, Mo.

ing near, and some were found also on the trunk of the cherry tree itself. These little pieces of leaf were all hollowed out between the upper and lower skins or epidermises and in the hollows thus made were tiny grubs, each piece of leaf constituting the home of a single grub. A number of the little cases were placed in suitable breeding-cages and in the early spring the little moths commenced to emerge, continuing until the middle of May, at which time they probably emerge out of doors. The insect in its different stages is shown in Fig. 9.

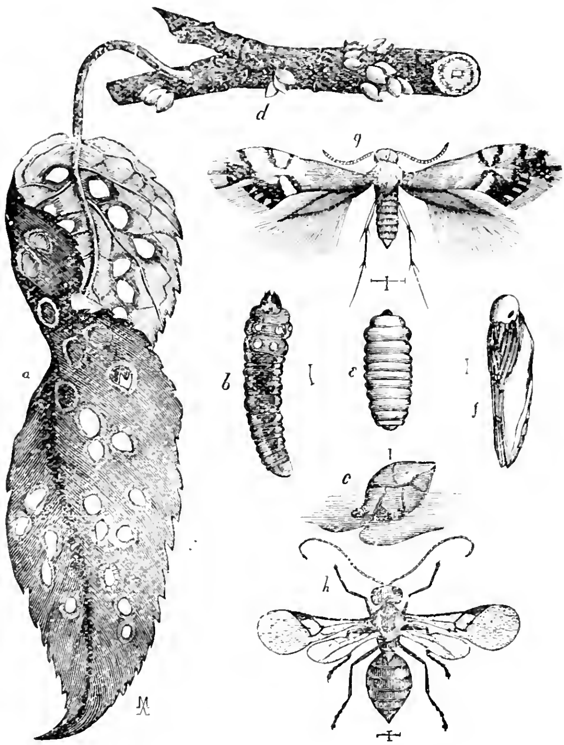

Fig. 9. Resplendent Shield-bearer, *Aspidisca splendoriferella*. After Comstock, Report of Entomologist for 1879, Division of Entomology, U. S. Department of Agriculture.

On September 1, 1898, the same insect was observed to be working on the same tree, part of the cases already cut out, while in other instances the insects were still in the mines getting ready to cut around themselves and thus transform the mines into cases. It is a fact worthy of note that while many of the leaves of the cherry remained on the tree at the time when the larvae were tying their cases up for winter, no cases were fastened to the cherry leaves, but almost all of them to the evergreen trees near by, or to the twigs and bark of the cherry tree itself, instinct thus guarding against the use of destructible supports.

While a healthy tree can easily withstand the attack of a few insects of this sort, the effect becomes more serious as their numbers increase, though if the insect would confine its attention to wild cherries no great harm might result. Unfortunately this case-bearer works also on apple and thorn-apple, as well as occasionally on pear, and its work is sometimes very serious. Luckily it is fairly conspicuous and easily recognized.

REMEDIES.

When the insect attacks fruit trees it can be kept in comparative subjection by the use of winter washes. Prof. Comstock recommends* a winter wash of lime and sulphur, using one-half bushel of shell lime to six pounds of powdered sulphur, and the mixture brought to the consistency of whitewash with hot water. This should be applied to all parts that can be reached. It is probable that other winter washes in common use against scale-insects also will prove beneficial here.

9. SOME INSECTS OF OUR SHADE TREES.

It is often of as much advantage to know which insects are harmless as to know which are injurious. Many insects are harmless for long periods of time and then, some season when the conditions are right, they multiply to a surprising extent and become, for a short time, serious pests, only to subside again quickly to their ordinary number. A large number of insects are conspicuous and attract a great deal of attention, while the damage resulting from them is so slight that it is insignificant. Much time and trouble are annually wasted in fighting insects that belong to this latter class. To both of these classes belong many insects working on shade and forest trees.

10. LEAF-MINERS AND CASE-BEARERS.

The leaves of shade and forest trees are often disfigured by patches of dead skin in the form of blisters or blotches of various shapes; sometimes irregular in outline, sometimes trumpet-shaped, and in other cases of all conceivable shapes and sizes. If we look more closely into the matter, we find that there is a good deal of regularity in the form and size of these blotches on any one kind of a tree, those found on a particular tree at a certain time usually being a good deal alike or belonging at most to two or three different sorts. These mines or blisters are the dwellings of small insects that live on the soft, succulent tissue found between the upper and lower surfaces or skins of the leaf. Very small indeed must an insect be to find room to live in such a place, but these little fellows do it, and sometimes congregate in such numbers as to seriously affect the trees.

11. WHITE OAK LEAF-MINER.

(*Lithocolletis cincinnaticlla* Clem.)*

An oak leaf-miner that multiplied to a surprising extent last summer is shown in

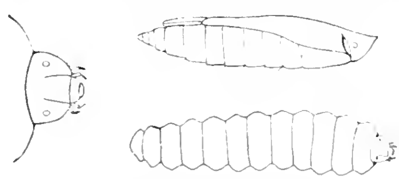

Fig. 10. Oak Leaf-miner, *Lithocolletis cincinnaticlla*, larva and pupa. (Original.)

Fig. 11, which represents the adult moth. The larva or grub, an enlarged figure of the head, and the pupal or resting stage, are shown in figure 10.

* Rep. Ent. U. S. Dept. of Agr. 1897, p. 212.

* This insect was kindly determined by Miss Mary E. Murtfeldt of Kirkwood, Mo.

Fig. 11. Oak Leaf-miner, *Lithocolletis cincinnatiella*. (Original.)

These dainty and minute moths were the parents of millions of grubs that so persistently attacked the white oaks all over the southern part of the State as to change the general color of the trees from a healthy green to a sickly brownish hue. Some leaves contained only one mine, but many contained two or three, while each mine contained from one to five or six larvae. The effect of thus destroying the breathing apparatus of the tree cannot but be injurious. This particular species is two-brooded in Michigan, the summer brood maturing about the middle of July and the spring brood some time in the spring when the foliage has become suitable for egg-laying. The summer brood passes the winter in the pupal or cocoon stage inside the mines in the leaves, each insect spinning a circular flat sheet of silk over itself to ensure its safety. The pupae fall, with the leaves, and pass the winter on the ground. If now we rake up the leaves and burn them, we shall destroy great numbers of the insects.

The following hymenopterous parasites were bred from this leaf-miner: *Sympiesis uroplatae*, *Chrysocharis albipes* Ashm., *Pteromalid* sp. *Sympiesis nigrofemora* Ashm., *Eulophus tricladus* Prov., *Orgilus coleophorae*, *Protopanteles monticola* Ashm. They were determined by Mr. Wm. Ashmead of the Dept. of Agr., at Washington, D. C., through the kindness of Dr. L. O. Howard.

Fig. 12. Basswood Blotch Leaf-miner, *Lithocolletis lucetiella*. (Original.)

12. THE BASSWOOD LEAF-MINER.

(*Lithocolletis lucetiella*, Clem.) †

Very many of our lindens or basswood trees were attacked by a leaf-miner, *L. lucetiella*, Clem., and though no damage resulted other than the injury to the appearance of the tree, their work was very conspicuous. Fig. 12 represents an adult moth of this species. The moths emerged on July 29.

Two more species were observed in quantity; one on the common locust (*Robinia pseudacacia*) and the other on a smaller variety used for ornamental purposes (*R. hispida*). The name of the insect is *Gracillaria robiniella*, Cham.* The leaf-miner in the common locust makes a blister mine more regular in shape. Its name is *Lithocolletis robiniella*, Clem.

Fig. 13 represents *Depressaria argillacea*, Wlsm.* found on linden.

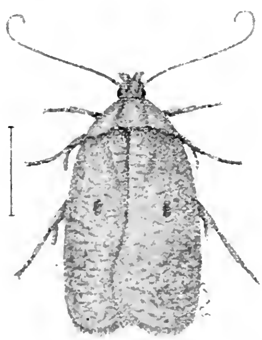

Fig. 13. *Depressaria argillacea* Wlsm. (Original.)

13. LEAF-MINER IN SUGAR BEET.

(*Pegomyia vicina* Lint.)

It was planned, during the season of 1898, to study the insects affecting sugar beets. Fields were examined wherever opportunity offered, but all the accessible ones proved to be remarkably free from insect attack; some of the leaves, however, were observed to be infested with a leaf-miner, which produced a blister-like mine on the upper surface of the leaf by eating out the succulent material between the upper epidermis and the lower. Specimens of such mined leaves were placed in a cage on June 28, and on

† A hymenopterous parasite, *Closterosterus tricinctus* Ashm., was bred from this miner. It was determined by Mr. Wm. Ashmead of the Dept. of Agr. at Washington, D. C., through the kindness of Dr. L. O. Howard.

* These two insects were determined by Miss Murtfeldt of Kirkwood, Mo.

Fig. 14. Sugar-beet Leaf-miner, *Pegomyia vicina* Lint. (Original.)

July 19 the adults (Fig. 14) emerged. They were about half the size of a house-fly and approached it somewhat in appearance. On examination they were found to belong to the family of flies known as Anthomyidae, which family contains many other flies injurious, in the maggot stage, to various vegetables, as the onion-fly, cabbage root-maggot, bean-maggot, etc. The particular species found in the beet leaves was first described, in 1882, by the late Dr. Lintner, State Entomologist of New York, where it was doing considerable damage. The beet leaves were so extensively mined that they could not be used for greens. Indeed, he reports that several cases of sickness were supposed to have been caused by eating greens infested by this insect.

While no serious trouble was experienced with this maggot during the past season, it is quite probable that the increasing acreage of beets in Michigan, brought about by the growing of beets for sugar, will furnish a place for these insects, as well as for others, to thrive.

There are a number of insects that are troublesome in Europe, and it is probably only a matter of time when we shall get some of them. It is to be hoped that any insects found injuring this crop will be immediately forwarded to the Entomologist, in order that, where necessary, investigations and experiments may be made to determine the best means of control. It is quite probable that sugar-beet leaf-miner is several brooded. When ready to pupate, most of the maggots pass out of their mines in the leaves into the ground, although some may remain in the leaves. The insects were not numerous enough last summer to allow experiments, but it is very probable that the destruction of the tops and the fall plowing and rolling will prove useful, as it will break up many of the puparia and bury them so deeply that the adults cannot get out.

14. THE HESSIAN FLY.

(*Cecidomyia destructor.*)

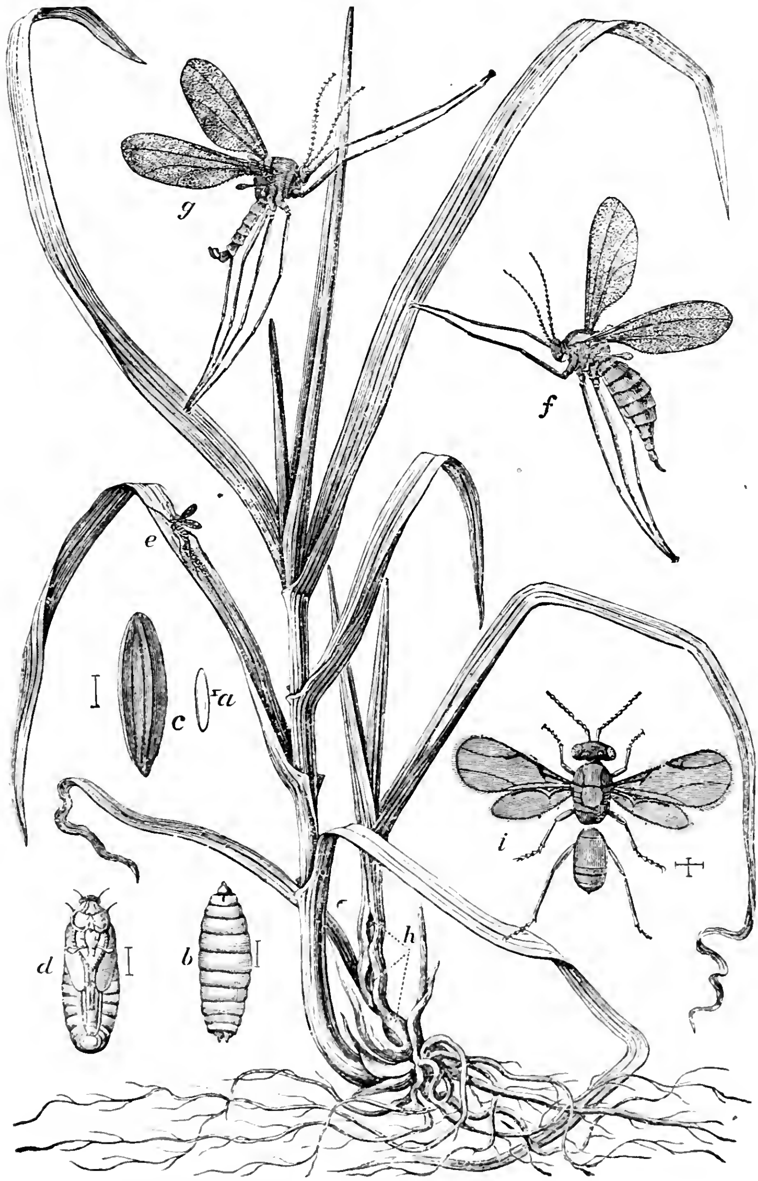

Fig. 15. Hessian fly. *Cecidomyia destructor.* After Packard. Third Report of Entomological Commission, Division of Entomology, Department of Agriculture.

For two seasons the growers of wheat, especially those in the northern part of the State, have been troubled with the Hessian fly, and as no detailed account of this insect and its method of work has been published in the Michigan bulletins for many years, a description of the pest may prove of interest.

As long ago as 1779, the Hessian fly was reported as doing injury in New York. It was for some time supposed that the insect was introduced into this country, in straw, by the Hessians employed by the British in our Revolutionary war, hence the name "Hessian fly." This explanation, however, has been shown since to be a questionable one. In 1837 the fly appeared at Paw Paw, Michigan, and has been troublesome from time to time in our State ever since.

Usually the first intimation a farmer has that the fly is present is the "lodging" of his wheat. An examination of an injured wheat plant is made and just below the point where the break occurs, usually just above the first, second or third joint, are found one or more little dark brown bodies (Fig. 15, c) about one-eighth of an inch in length. These are the puparia, often called the "flax-seeds," and correspond to the cocoons of many moths or the chrysalids of butterflies.

This brings us to the question of the stages through which insects pass in a lifetime. Most insects pass through four principal stages or what correspond to them, viz.—the egg, the larva (caterpillar or grub) stage, the chrysalis (cocoon or pupa) stage, and the adult stage. Now the third of these stages, the chrysalis or cocoon, is usually a quiescent one, the insect having little or no power of motion. In some cases it is only during this period that we can effectually combat some particular insects which do injury in some one of the other stages. In the case of the Hessian fly, the eggs are laid usually on the upper side of the leaf, singly or in small groups of two or three. In about four days they hatch and the minute maggots which come from them work their way down between the sheath of the leaf and the stem, where they commence to feed and to grow, at the expense of the plant. After a time the maggots become full grown and ready to pass into the pupal or flax-seed stage, when the outer skin becomes hard and rigid, forming a protecting shell, inside of which the insect can become a winged fly. This pupal or flax-seed stage is the one most likely to be first noticed. After a time the shell bursts and out comes a delicate fly of very minute proportions, the female fly ordinarily measuring one-tenth of an inch in length and the male slightly less.

The life cycle is probably passed through twice a year in Michigan, though in some states more time seems to be required and in others less.* For the winter brood the eggs are laid some time in late August, September, or early October, on fall wheat, usually just coming up. The young grubs go down to about the level of the ground and soon become full grown, ready to become pupae for the winter. In the spring they come out as adult, winged flies, and in April or May they lay their eggs on the young wheat. The young grubs of the spring brood behave just like those of the fall brood, except that they do not go so low down in the plant, usually working just above the first, second or third joint. All the adult flies do not come out at once, but occupy some time in doing so, with the result that the broods are not so distinct as would be expected.

NATURAL ENEMIES.

Fortunately this insect is kept in check ordinarily by other insects which prey upon it. These other insects belong to the group of parasitic hymenoptera and are very small. They lay an egg in the body of the maggot or on the pupa, which egg gives forth a still smaller grub that subsists on the living body of its host, after a time passing through a pupal stage and finally becoming an adult winged insect inside the remains of the Hessian fly maggot. At the proper time this winged insect, resembling a minute wasp, comes out and lays more eggs in other flies. These parasites usually keep the Hessian fly under control, but occasionally for some reason, climatic or otherwise, the parasites become reduced in numbers or are unable to devour all the flies, and then our wheat, rye, etc., suffer. If we know what a goodly supply of parasites are present in the fields, it is best to wait for them to destroy the flies and not to resort to measures which would destroy friend as well as foe. The presence of the parasites is best known by the small holes left in the wheat stem through which they emerge from the pupa of the fly. The fly itself, when uninjured by parasites, cracks open the shell of the flax-seed and crawls up between the sheath and stalk, but the parasite bores a

* Dr. Paul Marchal (Les Cecidomyies des Cereales et leurs Parasite Ann. de la Soc. Ent. de France, 1897) says they may be six brooded under the most favorable conditions.

round hole right through the sheath opposite the flax-seed. If these round holes are numerous in the fall, it is better to leave the stubble standing and to allow the parasites to destroy the flies, for they will do so far more thoroughly than we can ever hope to. Another way to detect the presence of parasites is to gather some of the infested joints and to enclose them in a fruit jar, over the mouth of which is then tied a piece of muslin. If the parasites are present, they will emerge after a time and appear as minute dark, four-winged insects, usually with metallic colors and moving with a quick, nervous, jerky flight, while the Hessian flies themselves are feeble little fellows with two wings and a weaker flight. This last method is of little use, however, since by it we cannot settle the question until too late to do us any good.

REMEDIES.

Burning Stubble.—Immediately after harvest, if possible, the stubble should be burned to destroy the flax-seeds that are present. Of course, this will destroy whatever parasites are present, and if these are plentiful it should not be done.

Fall Plowing.—When it is impossible to burn the stubble, and sometimes even when this has been done, it is found beneficial to plow the field immediately after harvest. If we wait for any length of time the flies will escape and then no amount of plowing will do any good. It is well to try to influence your neighbors to do likewise if they have wheat near yours, for it is very easy to infest one farm from another.

Late Sowing of Fall Wheat.—As the flies appear in the fall, during the latter part of August, and keep coming out all through September until early in October, it will easily be seen that if we delay sowing our wheat so that it will not appear above ground until after the first week or so in October, when the flies have disappeared, we shall escape them. It is usually sufficient to delay sowing until after September 20, but this varies somewhat with the season and latitude.

Traps.—When we delay the sowing of the crop until late in the season, as described above, it is always best to sow a strip of early wheat a few yards wide, entirely around the field, upon which the flies lay their eggs, as they will readily choose the advanced wheat to that just appearing, for purposes of egg-laying. This strip must be plowed under either *late* in the fall or *early* in the spring to destroy the young flax-seeds.

Rotation of crops is good practice and all volunteer wheat should be destroyed.

15. A LEAF-BEETLE FEEDING ON PEACH BUDS.

(*Chrysomela suturalis.*)

In November, 1897, Prof. U. P. Hedrick, then State Inspector of Orchards and Nurseries, gave us some small beetles (*Chrysomela suturalis*) which he had obtained from Mr. Higgens of Otsego, Mich. These beetles were said to injure the buds of peach trees in early spring, and as the habit is probably a new one to the species, it seems to be worthy of notice. According to Mr. Higgens, the beetles attacked the buds in April, before they had commenced to grow perceptibly, and especially those buds of fine varieties that had been "budded" or set in, devouring such buds by wholesale. As the beetle is considered, under ordinary circumstances, to be harmless, and known to feed only upon herbage, weeds, etc., of no value, its appearance was awaited with a good deal of interest last spring. Mr. Higgens kindly offered to notify us as soon as the beetles appeared, but fortunately they did not come.

The beetle in question is a small dark brown and white fellow about three-tenths of an inch long and having longitudinal stripes, as shown in the figure. (Fig. 16.) It is to be found at almost any time during a thaw in the winter, passing the winter in an adult condition, ready to commence work early in spring. It is to be hoped that this habit of eating peach buds is an acquired one brought about by the scarcity of more appropriate food, and that in future years the ordinary food of the beetle will be present in sufficient quantity so that it will not be driven to attack our peach buds. If, however, it appears again, a spray of one of the arsenites will at once kill it.

16. THE ELM-BORING SNOUT-BEETLE.

(*Magdalis armicollis* Say.)

A small brown or blackish beetle about five-sixteenths of an inch long, with the head prolonged into a long snout. (Fig. 17.) An examination with a lens shows

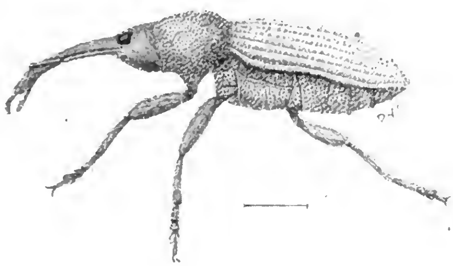

Fig. 17. Elm-boring Snout-beetle, *Magdalis armicollis*. (Original.)

the entire abdomen and thorax to be covered with small rounded pustules somewhat resembling shagreen.*

Specimens of this snout-beetle were sent us from Woodland, Barry county, on June 1, 1898. They were said to be very numerous on plum trees and were the cause of some anxiety. In replying to the letter it was explained that this insect was in habit a wood-borer and that most of the members of the genus work in oak, hickory or elm, at least so far as our species go. A careful examination was advised to see if the beetles were really doing any harm, as well as a search for dead or dying trees of the sorts indicated. On June 4 a reply was received, in which was the following statement: "Said trees (plum) are within about twenty feet of our wood-house, which is filled largely with elm limb wood, but none of the trees (elm, hickory or oak) are within twenty rods." The probable explanation is very apparent—the beetles, which burrow just under the bark of the dead and dying elm limbs, had been carried in great numbers in the limbs to the wood-shed and had remained there until their transformations were completed and the time arrived for them to come forth as mature beetles. On attaining maturity, they came out in great numbers and finding the plum trees in the near vicinity settled on them so thickly as to attract attention. Some idea of the great numbers present in the elm limbs can be obtained from this experience. The elm-boring snout-beetle seems to prefer dead or dying trees, or at least unhealthy ones, for its home. Advantage may be taken of this fact in fighting the pest. All dead or dying limbs or entire trees should be removed and burned by the first or middle of May; all branches and loose pieces of wood on the ground should receive the same treatment. By this practice we should receive a double benefit in woodland and forest if such treatment were practicable here, for at the same time that the insects were destroyed, we should remove one of the most efficient means of spreading fires.

In cases where valuable shade trees are involved, it may pay to use trap poles. These are simply poles of green elm set in the ground near the trees to be protected, at a time when the beetles are depositing their eggs. Now the poles being cut, and

* The specimens of this beetle received differ somewhat in color from the typical form, being almost entirely black. Specimens that were bred by the writer some years since, however, show great variation in size and color, some being quite black, and there is little doubt that the specimens obtained belong to the species *armicollis*.

therefore containing less sap, seem like unhealthy wood to the beetles, which prefer them to the more vigorous trees. The poles should be set during the last part of May and removed and burned some time in July, after making a careful examination to see if the young grubs are present. This method has been successfully employed in Germany in the case of another beetle having somewhat similar habits, and will prove useful in cases where the affected trees are valuable. Although these methods will not altogether exterminate the beetles, they should greatly reduce their numbers, so that the harm done will be comparatively slight.

While these insects prefer unhealthy wood to that which is healthy, they do not seem to know just where to draw the line, and their tunneling will sometimes cause the loss of an entire limb or even an entire tree, when but for them the loss might have been confined to one or two comparatively small branches. It is quite likely that they do occasionally attack healthy wood; at least it is thought that they greatly hasten the decay of healthy trees.

17. THE FRUIT BARK-BEETLE.

(*Scolytus rugulosus.*)

In 1878, Dr. LeConte noticed a small beetle working in the bark of fruit trees in this country.* Since that time the beetle has gradually spread over a considerable portion of the United States. Its first appearance in Michigan was in the season of 1897, but as only a single specimen of the work was obtained, with none of the beetles themselves, it was thought best to wait until more material was obtained before publishing an account of the pest, in order to guard against adding another care to the many troubles of fruit-raisers without sufficient reason.

The first intimation of the trouble is in the discovery of numbers of small drops of gum exuding from punctures in the body or limbs of peach, plum, cherry or apple trees. A closer examination reveals a small round hole a little less than one-sixteenth of an inch in diameter under each drop of gum. If now the outer bark around the hole be removed or pared away, a small burrow will be found to extend for a longer or shorter distance in the layer between the wood and the bark, sometimes branching considerably. These burrows or galleries usually exhibit a regular and definite arrangement (Fig. 18) when carefully examined; there is an egg or brood-chamber, short

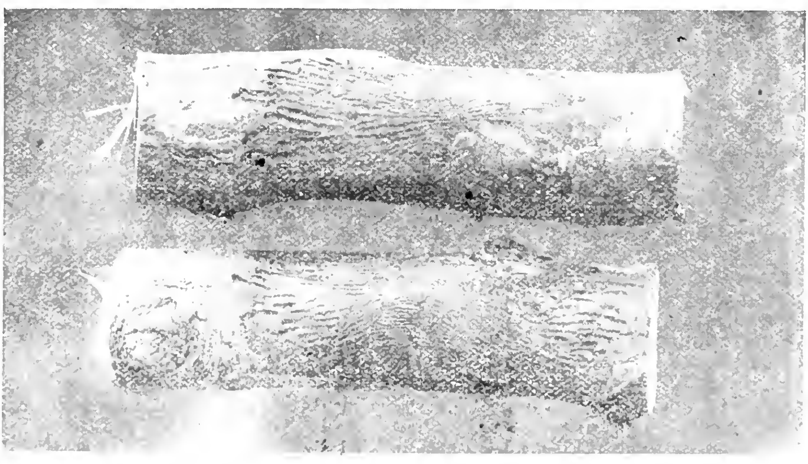

Fig. 18. Wood eaten by *Scolytus rugulosus.* (Original.)

and roomy, and from the sides of this chamber extend, in a direction more or less transverse to it, many slender galleries, small and narrow at the center, but gradually

* Am. Phil. Soc. (Proc.) Vol. XVII (1878) p. 626.

increasing in diameter until they attain full size at the periphery. The eggs are laid along the sides of the brood-chamber and the young grubs, on hatching, commence boring in the direction indicated, the regular increase in size being due to the growth of the grubs as they get further and further away from the parental burrow. When the grubs have attained their full size, they go a little deeper and pupate, coming out, in time, through holes bored to the surface, as adult, winged beetles.

In time, the effect on the tree of numbers of these borers is very marked, usually leading to its death.

The beetle (Fig 19) that causes all this trouble looks innocent enough, little more

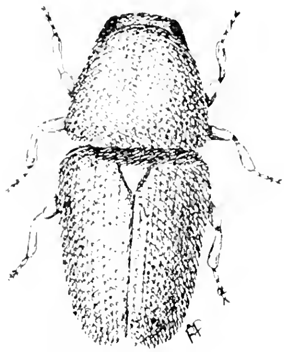

Fig. 19. Fruit Bark-Beetle, *Scolytus rugulosus.* (Original.)

than one-sixteenth of an inch in length, almost black, somewhat cylindrical, and covered with minute punctures or pits. It belongs to the family of bark-borers or scolytidae. The insignificant size of these little fellows almost makes them appear unworthy of notice, but we have most of us learned by this time that the very small pests are the most difficult to control, because they are usually present in such great numbers.

REMEDIES.

Most members of this family of insects greatly prefer to work in trees that are dying or that for some reason are not in a very vigorous condition at the time; hence when this insect is present it is imperative to keep trees especially well fertilized and in prime condition. When a tree is badly attacked, the cheapest course is usually to remove and burn it, as it merely serves to breed the pests and to furnish a source of infestation for the rest of the trees. Advantage may be taken of the preference of the beetles for sickly or dying trees, and if any worthless or comparatively poor trees are in the orchard, they may be girdled in midsummer in order to induce the beetles to take possession. This will serve as a trap to entice numbers of the beetles to the same spot. Of course the tree will have to be cut down and burned before the beetles emerge, which is said to take place in other states about the middle of June. The insect matures several broods during the course of a season.

When a tree is slightly attacked, the bark may be pared out where the tunnels occur, or the tree may be coated with whitewash to which a little Paris green has been added; this will tend to prevent any further infestation, and if the practice is persistently followed up it is said to be very useful as a preventive. The wash should be applied to all the trunks and limbs in the orchard.

Prof. John B. Smith, Entomologist of the New Jersey State Experiment Station, has carried on a number of successful experiments with hydraulic cement and milk for the peach-borer and it may be possible to use it against the fruit-bark beetle. The cement, when used with milk, makes a thin hard shell around the parts treated, which prevents the laying of the eggs. While it is not perfectly safe to recommend this remedy for the bark-beetle without careful trial, it is very probable that its use will be attended with considerable benefit.

18. THE STRAWBERRY SAW-FLY.

(*Harpiphorus maculatus* Nort.)

An old offender is the strawberry saw-fly. As early at least as 1868 this insect was reported in Michigan, Illinois and Iowa. This year they were reported from Bridgman, Stevensville and many places near. Specimens were obtained for us from Stevensville by Mr. David W. Trine, "State Inspector of Orchards and Nurseries."

The "worm" or false-caterpillar that does the damage is a dirty yellow or greenish naked caterpillar, not quite three-fourths of an inch long. Its yellow head bears three or more brown spots, one above and usually one on each side of the head, these spots being often more or less blended. There are twenty-two legs; six true legs, fourteen abdominal and two caudal pro-legs, making twenty-two in all. This will distinguish it from any lepidopterous or moth larva, for none of them living on strawberry has so many legs.

Early in May the eggs are said to be laid in slits cut in the stipule or leaf-stem of the strawberry leaf. The eggs hatch and the young false-caterpillars attack the leaves. They become full grown and descend into the ground, making a frail cocoon and there changing to the pupal form, ready to come out by the last of July or first of August, as adult saw-flies. These soon mate and lay the eggs for the second brood, which matures and goes into the ground during August or September. The specimens sent us were about ready to go into the ground on September 22, and the larvae disappeared from the fields very soon after that date, going into the ground to spin cocoons and remain until next year.

There is another species of saw-fly, *Monostegia ignota*, that closely resembles the species in question, but the heads of the larvae lack the brown spots already described. The two species, however, are so alike in habits that the same treatment will apply to both.

REMEDIES.

As in the case of the strawberry leaf-roller, it is impossible to use any true poisons on the plants after the fruit is set and before it is gathered, but if the worms appear before the plants bloom, a spray of Paris green and lime will quickly destroy them. After the plants have bloomed and before the fruits begin to ripen, they may be killed with kerosene emulsion applied very thoroughly so as to strike each worm. It would seem very probable that fine air-slaked lime and sulphur sifted freely over the plants would kill many of the worms, but this remains to be tried. The skins of saw-flies are more or less sticky and tender, and the powdered lime acts as a caustic on them. Lime and sulphur or lime alone is a very convenient remedy to use, because of its cheapness, ease of application (it should be dusted on the plants through coarse bagging), and ease of preparation, the fresh quick lime requiring only an occasional sprinkling sufficient to slake it, but not to moisten it enough to interfere with its slaking dry.

19. THE CRIMSON CLOVER-SEED CHALCID.

(*Bruchophagus funebris.*)*

When crimson clover was brought to America, it was hoped that a substitute had at last been procured for red clover, a substitute that produced a luxuriant growth and which was free from the many insect ills attendant upon the red clover. There is, nevertheless, a formidable insect foe that has appeared very recently, and which works in the seed. It belongs to the family of hymenopterous parasites known as Chalcididae, almost all of which are our friends. With a few exceptions, all the members of this family feed on other insects, acting as true internal parasites, and help in this way very materially to keep in check noxious species. They are all very small, wasp-like insects, smaller than mosquitoes and not conspicuous. The species in question lives in

* Determined by Mr. Wm. Ashmead of Dept. of Agr., Washington, D. C., through kindness of Dr. L. O. Howard.

clover seed and is slightly more than one-sixteenth of an inch in length, and black in color. As to its life history and habits, and the remedies that will control it, very little is known yet. The specimens obtained came out on July 12 in quantity, crawling out in swarms on the barn floor from a heap of newly threshed seed.

Prof. A. D. Hopkins of the West Virginia Experiment Station says* that the insects winter in the clover heads and that they work in the developing seeds of common red clover as well. Before any advice is given for the control of this insect, it will be necessary to determine the number and dates of the broods and considerable more about its life history than is known now. It is hoped that during the coming summer we may be able to learn more.

20. JUMPING OAK-GALL.

(*Neuroterus q-saltatorius*, H. Edw.)

Everybody is familiar with the oak-galls or oak-apples to be found growing on the leaves and twigs of oak trees. Many kinds or species occur in Michigan and each kind is made by a different insect, usually by a member of the family of insects known as Cynipidae. One of these galls or oak-apples is so different from all the others and so curious in itself that it well merits a brief description.†

The galls in question were obtained from Kalamazoo on June 30, 1898, and were sent us by Mr. Hurlburt. Later the same species was found by the writer on the College grounds. The minute galls were to be found in great numbers in tiny pits on the under side of the leaves of the burr-oak (*Quercus macrocarpus*). The form is shown by the accompanying figure (Fig. 20), which is greatly enlarged. The

Fig. 20. Jumping Oak-Gall, *Neuroterus q-saltatorius*. (Original.) From a photomimeograph.

* Proc. 10th Ann. Meeting of Am. Assn. of Econ. Ent. Pub. in Bull. 17, New Series Dept. of Agr. Div. of Ent. 1898, p. 45.

† This insect was kindly identified for me by Dr. L. O. Howard of the Dept. of Agr., Washington, D.C.

galls themselves are less than one-sixteenth of an inch in size, and if they were black instead of yellowish white, they would closely resemble small bird shot. The curious part about the matter is the lively nature of the galls. When the specimens were first received, about a teaspoonful were emptied out on a clean paper and they immediately commenced jumping about, looking something like miniature corn popping. They threw themselves straight up into the air for about half an inch, very many times their own diameter, with the most astonishing vigor. This jumping without legs gives the performance rather a strange appearance. On opening one of the tiny balls, it was found to consist of a very thin papery shell, enclosing a minute white grub, and it is the sudden and convulsive movement of this grub that causes the jumping. The amount of strength required to throw itself to such a height when closely confined in a tight shell is something amazing.

The use of this power or habit is quite apparent; the galls being very delicate and fragile would stand a poor chance if left on the surface of the ground where animals are constantly walking, and being so small and seed-like, might even be eaten by birds; the jumping causes them to be sifted into cracks and crannies, where they are protected and where they can pass the winter in comparative safety.

The name of this curious insect is *Neuroterus q-saltatorius*, H. Edw.*

21. ANTS IN CORKS.

(*Camponotus herculaneus*, var. *pennsylvanicus.*)

On August 27, 1898, a peculiar specimen was received from the Sprudel Salt Co. of Mt. Clemens. A bottle that had contained mineral water had been attacked by ants and a passage bored through the cork of sufficient size to allow the contents to escape. Several of the ants were found inside the empty bottle. They proved on examination to be *Camponotus herculaneus*, var. *pennsylvanicus*. As the damage did not occur at the works of the company, but in a small village in another state, it was impossible to get very much information in regard to the details and extent of the trouble.

The species is one of our common wood-boring ants, a large black insect found in old or decaying logs and stumps, and occasionally in the timbers of our houses. As a remedy to be used in case the trouble should become serious, it was suggested by the writer that the tops of the bottles be dipped in melted sealing wax or resin to form a coat distasteful to the insects.

CARBON-BISULPHIDE FOR INSECTS IN SEEDS AND GRAINS.

Seeds infested with insects, such as weevils, grain-beetles, meal beetles, etc., ordinarily are best freed from the pests by the use of carbon-bisulphide.

A careful germination test of beet seed treated with this liquid was made to determine definitely whether it was safe to thus treat beet seed in order to rid it of any insects that might infest it. Three separate lots of seed were exposed to two different strengths of the gas for different lengths of time.

In lot No. 1, 100 fruits, each containing from one to seven true seeds, were exposed for twenty-four hours to the gas at the rate of two drams of the liquid to a cubic foot of air space.

In lot No. 2, 100 fruits were placed in an atmosphere saturated with the gas for twenty-four hours.

In lot No. 3, 100 fruits were placed in a jar without any of the liquid, as a check on the others.

In lot No. 4, 100 fruits were placed in an atmosphere saturated with the gas for forty-eight hours.

The seeds employed were Vilmorin's Improved.

After the seeds had been subjected to the action of the gas for the required time,

* An undetermined Pteromalid and Tetrastichus sp. were bred from this gall. They were determined by Mr. Wm. Ashmead of the Dept. of Agr., Washington, D. C., through the kindness of Dr. Howard.

they were placed between moist sheets of filter-paper, each lot under a separate bell-jar. In the case of lot No. 1, 93 of the 100 fruits germinated at the end of two weeks; in lot No. 2, 76 germinated; in lot No. 3 (check), 93 germinated, and in lot 4, 50, in the same length of time.

Exposure to the weaker strength (two drams to the cubic foot) somewhat accelerated the germination without injuring the seed, while exposure to the stronger gas killed the seed directly in proportion to the time exposed.

The gas is strong enough when used in the lesser rate to kill all insects and vermin that may infest it. Great care must be employed in using the substance, for it is explosive when lighted and very poisonous to breathe. The seed or grain should be in air-tight bins or barrels, and means should be at hand to close them tightly and quickly. The space in the bin or barrel should be computed, counting in any air-space above the seed, for the gas will occupy the space, too. For every cubic foot of space, one dram of the liquid should be used; for every 100 cubic feet one pound of the liquid will suffice. Shallow pans or dishes should be placed on top of the seed and the liquid poured into them, after which the bins or receptacles should be quickly and tightly closed. Wet blankets and old carpets will do very nicely for this purpose if enough of them are used.

If the seed or grain is more than three or four feet deep, some of the liquid should be poured into it at some depth to ensure its spreading evenly and filling all the space treated. This is easily done with a piece of gas-pipe fitted with a wooden stick for its entire length. The pipe, with the stick in place, filling the hole, is thrust down half way, the stick is withdrawn and the liquid poured down through the pipe. The stick merely prevents the pipe from being filled with grain when pushed into place.

The liquid carbon-bisulphide, on being liberated, will be quickly transformed into a gas, which, being heavier than air, settles to the bottom and fills all the air-spaces between the seeds or kernels. The liquid costs about 30 cents for a single pound, or about 10 cents per pound when purchased in 50 pound lots. It can be used to kill insects in the granary, in the pantry, clothes moths, and in fact any insect in material that can be placed in trunks, chests, or barrels that can be tightly closed. In general, one dram should be used for a cubic foot of space, as some seeds are injured if subjected to too strong a treatment. The work must be done in the daytime, away from lamps, stoves or fires of any sort, and no fires must be allowed to come near it until everything has been aired thoroughly. Grain should be shoveled over several times. Great care must be observed to breathe as little as possible, for it is very dangerous and will as easily produce death among men as among insects.

FORMULAS AND DIRECTIONS FOR USE OF INSECTICIDES.

To be of much service, spraying must be thoroughly done. A conscientious and thorough spraying will wet every part of every limb, twig and leaf on both sides. To accomplish this result cheaply and surely, a spray as fine and mist-like as possible must be used. When a poor nozzle is used, one that projects a coarse spray composed of distinct drops of liquid, much is sure to fall to the ground and be lost. Good nozzles save enough insecticide to pay for themselves in a short time. When contact insecticides, such as kerosene emulsion or whale oil soap, are used, each insect must be fairly hit with the liquid to be killed.

Insects that chew or bite their food are usually most cheaply and effectually killed with arsenites, such as Paris green, while those that suck their food from beneath the surface of the plant have to be killed by contact insecticides, such as kerosene emulsion, whale oil soap, etc. In some cases insects that chew have to be killed with contact insecticides; for instance, when they are on fruits or vegetables nearly mature or on which it would be dangerous to use Paris green because of its poisonous properties.

The pump should be strong and well made, of sufficient capacity to throw the one or two sprays required without too great exertion. An attempt to spray a large orchard with a pump designed for use on small garden plants is discouraging, to say the least.

When large, high trees are to be sprayed, it is often found best to build an elevated stage on top of the wagon-tank or over the barrel containing the liquid. To reach the top of the tree, it is usually best to fasten the nozzle to the tip of a strong

bamboo or to attach it to a length of half-inch gas pipe and send the stream of liquid through the gas pipe. At least fifteen feet of hose should be allowed in order to reach all parts of the tree.

Never spray a tree when in bloom; it may kill bees, both wild and hive bees.

Stone fruits require especially careful treatment; they are easily injured by sprays not properly mixed or prepared.

INTERNAL POISON FOR INSECTS THAT CHEW,—PARIS GREEN.

At the head of all the stomach poisons stands Paris green or arsenite of copper. To prepare Paris green for spraying, slake one-pound of well-burned quicklime in hot water and stir in one pound of Paris green. Allow this mixture to stand over night, strain, and then stir it into from 150 to 250 gallons of water. Keep the liquid well stirred while spraying. For most insects, one pound to 200 gallons of water is sufficient, and at this rate it will not injure the plant. Stone fruits, such as peach, plum and cherry, should not receive a spray much stronger than this, but apples, pears, etc., may be sprayed with a mixture considerably stronger, viz., one pound to 150 gallons of water. Potatoes may be sprayed with one pound to 100 gallons of water. Paris green is fairly uniform in composition if not adulterated, and is perhaps the safest and surest remedy for chewing insects as a whole.

DRY METHOD.

While ordinarily it is most economical to use Paris green in the form of a spray, in some instances, where only a few plants are to be treated or where no pump is available, it is expedient to use it as a dry powder. It should then be mixed at the rate of one pound of the poison to 100 pounds of plaster, flour, or air-slaked lime, and dusted on the plants through a sack of burlaps or some loose, coarse cloth. It is best to make the application in the morning when the dew is on the plants. Never apply dry poisons where the wind can blow the powder into pastures or places where cattle or horses are feeding.

ARSENATE OF LEAD.

This poison, although not in general use throughout the country, has several advantages; it shows where it has been applied; it is light and does not require such vigorous stirring as Paris green; it does not easily burn the foliage, and it is cheap. To prepare it, dissolve four ounces of arsenate of soda and eleven ounces of acetate of lead, each in a gallon of water. On mixing the two solutions together we shall get a milky precipitate, which should be stirred into 100 gallons of water. It is now ready for spraying. Of course, larger or smaller quantities may be made in the same proportion, and if this preparation does not seem strong enough, it may be applied much stronger with safety.

Its action is slower than that of Paris green, but the fact that it does not readily burn foliage is an advantage when spraying various kinds of trees with one mixture.

CONTACT INSECTICIDES, FOR INSECTS WHICH SUCK THEIR FOOD.

The most effective contact insecticides are kerosene emulsion and whale-oil soap. Kerosene emulsion may be used against all lice (except bark-lice), bugs, etc., which do not succumb to the internal poisons. To be effective it must be very carefully made and conscientiously applied.

Place two gallons of ordinary kerosene in a warm place, either in a warm room or in the sun, and allow it to become as warm as possible without danger from fire. Boil one pound of laundry soap or whale-oil soap in a gallon of soft water until completely dissolved. If the water is the least bit hard, "break" it with washing soda. Remove the soap solution from the fire, and while still boiling hot add the kerosene and agitate for ten minutes, or until the oil is emulsified, with a spraying pump, by forcing the liquid back into the vessel from which it was pumped.

When the liquid is perfectly emulsified it will appear creamy in color and will flow evenly down the side of the vessel. Care should be taken to completely emulsify the oil, and this is accomplished much more easily when the mixture is hot. This strong emulsion may now be readily diluted with water and used, or it may be stored away for future use. When cold it becomes like sour milk in appearance, and should be dissolved in three or four times its bulk of hot water before diluting with cold water.

Small amounts of this emulsion may be made by using the ingredients in small quantities, but in the same relative proportion.

It should be diluted ten times for most insects, but many plants are able to resist a stronger mixture, which is usually more effective.

WHALE-OIL SOAP.

This insecticide is rapidly coming into favor. It may be used at the rate of one pound to from four to six gallons of water for plant-lice and many other insects. For winter spraying it is used at the rate of two pounds to a gallon of water. This is the most effective remedy known against the San Jose scale.

Whale-oil soap should cost about four cents per pound when bought in quantity. It requires no preparation other than dissolving in water, and ordinarily is easily applied. Care should be observed to get an article that will not turn to a jelly when dissolved at this rate, for jellied soap is very difficult to spray. The above strength, two pounds to a gallon, should never be applied except in the winter when the trees are entirely dormant, for an application when the buds are swelling or when the leaves are on the tree is sure to do injury to the tree.

PYRETHRUM.

(Buhach or Persian Insect Powder.)

Pyrethrum is a powder made by grinding the heads of a plant resembling our daisy. It is produced in great quantities in California, where it is sold under the proprietary name of "Buhach." It is also imported from Persia and known as "Persian Insect Powder." Now, the insecticidal value of the Pyrethrum lies in an oil which readily passes off into the air, and to prevent the loss of this the powder should always be kept tightly sealed in metal cans. Insect powder that has been exposed for sale in open cans in drug store windows is next to worthless, and should on no account be purchased. This insect powder is harmless to all animals breathing by means of lungs. It can be used either dry or in the form of an alcoholic extract. To apply it dry, dust the powder on the insects either by means of a bellows or in some other way. To apply in the form of an extract, place four ounces of the powder in a pint of alcohol, leave it for a week and filter, then dilute once with water, and apply with an atomizer.

HELLEBORE.

White hellebore is the powdered root of a plant. It kills both by contact and as an internal poison. It may be applied either dry or in the form of a liquid. When used dry it should be mixed with three or four times its weight of flour or plaster and then dusted on the insects. Applied wet, one pound should be mixed with twenty-five gallons of water and this liquid applied as a spray. A convenient form of duster is made as follows: A tin box like a pepper box, holding a quart or less, is fastened to a stick about six feet long by means of a screw running through the bottom of the box into the stick. The cover of this box should be finely perforated to allow the poison to come out very slowly when shaken. This box can then be shaken over the infested plants and the insects peppered or dusted with the poison.

Hellebore is especially useful against all moist-bodied insects, such as currant worms, pear and cherry slugs, etc., for the poison sticks to their bodies.

STRAWBERRY NOTES FOR 1899.

BY L. R. TAFT AND H. P. GLADDEN.

Bulletin 176.—Horticultural Department.

For a number of years an endeavor has been made to procure all of the new varieties of strawberries, and originators of new sorts have been urged to send plants of their more promising varieties for trial. In this way we have been able to secure a large number of the kinds that are being brought to the attention of the public by the small fruit plant specialists.

The soil upon which we have tested the varieties mentioned in the following bulletin is a moderately heavy loam, which has for a number of years been used for growing vegetable crops. The fertility has been maintained by the use of liberal amounts of stable manure and the land was in a good condition for growing the plants as far as plant food was concerned, although the soil would not be selected as one adapted for small fruit culture.

The plants were set in May, 1898, in rows four feet apart and at intervals of eighteen inches in the rows. One-half of the plants of each variety were allowed to form narrow matted rows, while the remainder were kept in hills. For the most part the number of plants was twenty-five, but in a few instances only twelve were secured.

During the summer of 1898 the plantation received frequent cultivation and an occasional hoeing, and after the ground had frozen a mulch was applied. In the spring the mulch was removed from over the plants and placed between the rows, where it served to keep down the weeds and to hold the moisture. During the first week in June the plants began to show the lack of moisture in the soil and the block which contained the plants on which notes were taken was thoroughly irrigated. The water was applied at the rate of about 800 barrels per acre and was allowed to run down the rows in furrows. After the water had soaked into the ground the mulch was replaced, and the soil was sufficiently moist to the end of the season, and no injurious effect of the dry weather was noticeable. On the other hand, a strip which was not irrigated showed the effect of the dry weather to a marked degree, and the fruiting season was shortened nearly one-half, while the injury to the crop was even greater.

In the following table the characteristics of the varieties are expressed by letters and figures, according to the key that is given at the beginning. The rating of firmness, quality, vigor and productiveness are on the scale of 1 to 10, with ten as a maximum.

STRAWBERRIES.—TABLE OF VARIETIES.

ABBREVIATIONS.

Form.		Size.	Sex.	Color.	
b broad.	l long.	s small.	p pistillate or imperfect.	b bright.	l light.
c conical.	o oval.	m medium.	b bisexual or perfect.	c crimson.	r red.
d depressed.	r round	l large.		d dark.	s scarlet.
i irregular.					

Plants set May, 1898. Name of variety.	Sex.	Vigor (1 to 10).	Date of bloom.	First ripe fruits.	Last fruits.	Productiveness.	Size.	Form.	Color.	Quality.	Firmness.
Anlo	p	8.5	May 25..	June 10.	June 23.	8	l	b c	d s	8.8	8.5
Anna Kennedy	p	8.8	" 26..	" 13.	" 24.	8.8	m l	r c	b s	9	9
Apache	b	10	" 23..	" 6.	" 20.	9.1	m	l c	l s	5	8
Arkansas Traveler	b	9.4	" 27..	" 12.	" 23.	8.3	l	r c	d c	8.8	8.5
Armstrong	b	9.8	" 24..	" 9.	" 24.	9.1	l	b c	l s	8	8
Arnout	b	7	" 27..	" 13.	" 22.	9.4	s m	l b c	b d s	8.5	9
Arrow	p	9	" 23..	" 6.	" 24.	9	m l	l c	l c	9.5	8.5
Avery	p	8	" 27..	" 12.	" 22.	8.5	m	l c	b d s	9.5	7.5
Beder Wood	b	8.8	" 24..	" 9.	" 23.	9	m	r	l c	8	8.5
Berry	p	8	" 27..	" 9.	" 21.	7	m	r c	d c	9	9
Bethel	p	9.4	" 26..	" 6.	" 22.	8	m	b c	d c	9.5	8.8
Bisel	b	9.8	" 26..	" 8.	" 26.	9.1	m	b c	b c	9	9
Bismarck	b	9	" 27..	" 9.	" 23.	9.1	l	r c	d c	8	8
Blonde	b	9	" 26..	" 8.	" 22.	8.5	m	r c	l r	8	7.5
Bostonian	b	9.8	" 26..	" 10.	" 24.	7.8	m l	r c	b s	9.8	9
Brandywine	b	9.8	" 28..	" 12.	" 27.	9.5	l	r c	b d c	9.5	8.5
Brownie	b	9.7	" 25..	" 8.	" 21.	8.8	m l	r c	b l s	9	8.8
Bryant	b	9.8	" 24..	" 10.	" 24.	9.8	l	b c	b d c	7	9.5
Bubach	p	8.8	" 26..	" 10.	" 22.	9	l	d c	l c	9	8
Burnett	b	9	" 25..	" 9.	" 21.	8.8	l	r c	b c	9.5	8.2
Champion	b	9.8	" 24..	" 10.	" 22.	9	m	r c	b s	9.2	9
Chenango	b	9.7	" 26..	" 8.	" 20.	8.5	m	r c	l s	7.5	8.8
Cherokee	p	9.3	" 24..	" 7.	" 21.	8	m	r c	c	9	8.5
Clyde	b	9	" 24..	" 5.	" 21.	9.5	l	r c	l s	9	8.5
Cobden Queen	p	9.7	" 24..	" 9.	" 22.	8.8	l	r d c	l s	7.8	7
Columbus	b	9.7	" 23..	" 10.	" 21.	8.7	l	r c	b s	8.5	8.5
Crescent	p	10	" 23..	" 5.	" 21.	9.8	m	r c	l s	8	8 5
Darling	b	8.5	" 25..	" 10.	" 20.	4	s	r c	d c	9	8.5
Dakota	b	9.5	" 24..	" 7.	" 19.	8	s	l c	d	9	7
Dictator	p	9.8	" 26..	" 10.	" 22.	9	m	r c	r	7.5	8.5
Dollar	b	9.2	" 26..	" 12.	" 21.	7	m	l c	b s	9.2	9
Drought King	p	9.8	" 24..	" 6.	" 20.	9.6	m	r c	d s	8	8.5
Early Bird	b	7.5	" 24..	" 5.	" 20.	6.8	s	i	l c	7.5	8
Early Jack	b	9.7	" 23..	" 5.	" 20.	9	s m	i	s	7	7
Eleanor	b	9.5	" 24..	" 8.	" 21.	8	s	i	b s	8	8.5
Enhance	b	9.5	" 24..	" 6.	" 23.	9	m	i r c	d s	9	9
Epping	p	8.5	" 26..	" 9.	" 23.	9	l	r d c	s	8	9
Equinox	b	8.8	" 27..	" 8.	" 24.	8.6	s	d c	c	8	8.5
Evans	b	9.4	" 25..	" 10.	" 23.	8	m l	r c	l s	9	7.5
Excelsior	b	10	" 26..	" 1.	" 20.	9	l	l c	b s	8.5	8.5
Flash	p	7	" 25..	" 10.	" 22.	9	l	b c	d c	9.5	9
Fountain	b	8.8	" 26..	" 12.	" 23.	9.2	l	b c	v d c	9	9.2
Fremont	b	9	" 25..	" 9.	" 24.	8.5	m l	c	b s	9	8.8
Gandy	b	9.7	" 28..	" 14.	" 28.	8.5	l	b c	l c	8.5	8.5
Garringer	b	4	" 27..	" 10.	" 24.	8.8	l	b e	b d c	9.8	9
Gen. Fifer	b	7	" 24..	" 12.	" 22.	8.5	m	r c	b r	9	8
Gertrude	b	8	" 23..	" 10.	" 21.	5	s m	b c	l s	8	8.5
Giant	b	9.7	" 23..	" 9.	" 22.	9.6	l	r c	d c	9.8	9.5
Glen Mary	b	9	" 27..	" 10.	" 24.	9.5	l	c	b s	9	9
Greenville	p	8.7	" 25..	" 7.	" 23.	9	l	r d c	b c	8.5	7.5

STRAWBERRIES.—CONTINUED.

Plants set May, 1898. Name of variety.	Sex.	Vigor (1 to 10).	Date of bloom.	First ripe fruits.	Last fruits.	Productiveness.	Size.	Form.	Color.	Quality.	Firmness.
Hatch Exp. Station	b	8.5	May 26..	June 10.	June 22.	8.5	l	r c	d c	9.5	8.5
Haverland	p	9	" 24..	" 9.	" 23.	9.8	m	l c	s	8.5	8.5
Heflin No. 3	p	9	" 24..	" 6.	" 22.	8.5	s m	s d c	d c	9.5	8.5
Henry	b	4	" 27..	......	......	......	......	......	......	......	......
Herbst	b	7.5	" 25..	June 12.	June 23.	6.5	m	l c	v d c	7.5	9.5
Hersey	b	9.2	" 26..	" 6.	" 21.	6	s	r c	v d c	9.5	8
Hilton Gem	b	8	" 25..	" 7.	" 21.	7.5	l	l c	b d s	9	8.8
Holland	p	9.8	" 26..	" 10.	" 22.	9.2	m	l b c	d c	9	9
Homestead	b	8	" 26..	" 10.	" 22.	7	s	i	r c	9.8	7
Hood River	b	7	" 25..	" 9.	" 23.	8.7	m	r c	b c	9.7	9
Hoosier	b	9.2	" 26..	" 9.	" 23.	9.3	l	l c	d c	9.5	9.5
Hull No. 3	b	9.8	" 26..	" 8.	" 21.	9.2	m	d c	l s	9	7
Hunn	p	8.8	" 25..	" 9.	" 22.	8.2	l	r c	d s	9	9.5
Ideal	b	8.5	" 25..	" 6.	" 23.	......	m l	r c	b d	9	9
Ima	p	7.5	" 25..	" 10.	" 22.	6	s	r c	d s	8	9
Jarbalo	b	9.4	" 24..	" 10.	" 21.	8.5	m l	r c	d c	7.5	8.5
Kansas	b	8.5	" 24..	" 6.	" 21.	8.5	m	r c	d c	9.5	8.5
Karl	b	9.6	" 25..	" 7.	" 27.	5	s	l	d c	6	6
King Worthy	b	7	" 25..	" 12.	" 22.	9.1	l	r c	d s	8	7.5
Knight	b	7.5	" 26..	" 10.	" 22.	8	l	r c	b d s	9.5	9.2
Kossutn	b	8.5	" 25..	" 8.	" 23.	8.8	m	r b c	d c	9.2	9
Lady Franklin	p	9.8	" 24..	" 6.	" 24.	8.5	l	b c	d c	9.8	7.5
Lady Thompson	b	9	" 24..	" 6.	" 22.	9	l	r c	d s	9	9
Lanah	b	9.8	" 26..	" 5.	" 21.	7.5	m	c	l s	8.5	9.4
Lehigh	p	4	" 27..	" 10.	" 22.	7	s m	r c	b d s	8	8.5
Leroy	p	9.5	" 24..	" 6.	" 24.	9.5	l	d c	d c	9	9
Little No. 7	b	8.5	" 26..	" 6.	" 23.	8.5	m	r c	d s	8.5	8.8
Little No. 8	b	9	" 24..	" 9.	" 24.	8.8	m	b c	d c	9.5	9
Little No. 40	p	8.8	" 24..	" 9.	" 26.	8.8	l	b c	b c	9	9
Lovett	b	8	" 27..	" 10.	" 21.	9.1	m	r c	b c	8	9
Magoon	b	7	" 26..	" 7.	" 21.	4	m	i	d c	9.5	8.5
Margaret	b	8.5	" 25..	" 9.	" 24.	9	l	b c	d c	9.2	9
Marguerite	p	3	" 26..	" 10.	" 21.	......	......	......	......	......	......
Marshall	b	7	" 28..	" 12.	" 27.	9	l	r c	d c	8.5	9
Marston	p	9.6	" 24..	" 7.	" 26.	9	m	r d c	l r	7	8.8
Mary	p	5	" 27..	" 10.	" 22.	5	l	b d c	b c	7	9
Maximus	b	5	" 27..	" 10.	" 21.	4	m	l c	d c	9.8	8.8
Mayflower	b	10	" 23..	" 2.	" 20.	8.5	m	l r c	b s	8	8
McKinley	b	7	" 26..	" 12.	" 22.	8	m	l c	d c	9.4	9
Mele	p	8.4	" 27..	" 10.	" 24.	8	l	r c	b d c	9.5	9
Meridian	p	9.7	" 26..	" 9.	" 24.	9.5	m	r	l s	7.5	8
Michigan	b	7.5	" 29..	" 15.	" 30.	8	l	b c	b c	9.8	9.8
Milton	b	7	" 26..	" 6.	" 21.	7	m	l b c	d c	9.5	9
Mineola	b	5	" 27..	" 10.	" 22.	6.5	m	r c	d s	7.5	7.5
Morgan Favorite	b	9.4	" 26..	" 9.	" 26.	9.4	l	r c	b c	9.8	9.2
Nan	b	7.5	" 22..	" 10.	" 22.	8.5	m	r c	l c	9.2	9
Nick Ohmer	b	6	" 27..	" 12.	" 24.	8.3	l	o c	b c	9.4	9.5
Nina	b	8.8	" 26..	" 10.	" 23.	8.5	m l	r c	b s	9.2	8
No Name	b	9.2	" 24..	" 6.	" 24.	8.5	l	b c	d c	9	9
No. 1000	p	8.8	" 26..	" 8.	" 21.	8.5	l	b c	b d c	9	9
Noland	p	9.2	" 26..	" 7.	" 21.	8.8	l	r c	d c	8.8	8.5
Omega	p	7.5	" 24..	" 7.	" 33.	9	l	r c	v d c	9.2	9
Ona	p	6.5	" 26..	" 6.	" 22.	7	s	r c	b d s	9.8	8.5
Orewiler	b	9.4	" 27..	" 10.	" 24.	8.5	l	o c	b c	9.6	8
Oriole	p	6.5	" 27..	" 9.	" 24.	8	m	r c	b s	9	9
Parker Earle	b	8	" 24..	" 12.	" 27.	9.4	m	d c	d s	8	9
Parker Earle, Jr.	b	8	" 25..	" 10.	" 27.	8	m	d c	d s	8	9
Patrick	b	7.5	" 26..	" 12.	" 24.	8	s	b c	l s	8	9.4
Peabody	b	9.6	" 23..	" 5.	" 24.	9.5	m	b c	b s	7.8	7.5
Pet	b	8.8	" 27..	" 10.	" 21.	7	m l	b c	b d s	9.2	9

STRAWBERRIES.—CONCLUDED.

Plants set May, 1898. Name of variety.	Sex.	Vigor (1 to 10).	Date of bloom.	First ripe fruits.	Last fruits.	Productiveness.	Size.	Form.	Color.	Quality.	Firmness.
Phippen	b	9	May 24..	June 9.	June 22.	9	m	l c	b c	8.8	9
Phenix	b	9	" 26..	" 6.	" 21.	8.5	m	r c	d c	8	8
Plow City	b	8	" 25..	" 10.	" 24.	8.1	m	l c	b s	9	8.5
Ponderosa	b	9	" 27..	" 10.	" 24.	9.4	l	b c	d c	9.5	9.5
Portage	b	8.5	" 26..	" 8.	" 21.	9	l	l c	b s	8	9
Pride of Cumberland	b	9	" 24..	" 9.	" 22.	8.8	m	r c	b s	8	7.8
Pride of Ohio	b	9.4	" 26..	" 10.	" 22.	8.5	m	r c	b s	9.5	9.2
Purdue	p	9.2	" 27..	" 6.	" 24.	9.5	l	r c	d s	8.5	9
Ridgeway	b	9.2	" 24..	" 8.	" 26.	9.6	l	r c	b c	9	8.5
Rio	b	8.8	" 23..	" 6.	" 24.	8.2	m	l c	b s	9	8.5
Ruby	p	8.5	" 26..	" 9.	" 24.	9	l	r d c	b r	9.5	9.5
Sample	p	10	" 25..	" 8.	" 28.	9.8	l	b c	d c	9.8	9
Satisfaction	b	9.2	" 24..	" 8.	" 24.	7.8	s m	l c	b d c	9.8	8.8
Scriver	b	9.8	" 24..	" 6.	" 24.	7.2	m	l c	d c	9.6	8
See No. 1	b	9.2	" 23..	" 8.	" 21.	8.5	s	r c	b s	8	9
See No. 2	p	9.8	" 23..	" 9.	" 21.	9.5	m l	l c	b d s	9	9
See No. 3	p	9.8	" 28..	" 9.	" 26.	9.5	l	r c	b s	9.5	9
See No. 4	p	9.8	" 27..	" 9.	" 26.	9.6	l	b c	b s	8.5	8.5
Seek-no-further	b	9.7	" 26..	" 6.	" 22.	8	l	r c	l s	9	8
Seneca Chief	b	9	" 26..	" 10.	" 26.	7.6	s m	r c	d s	10	9
Smith	b	9.8	" 24..	" 6.	" 21.	8.8	s m	r c	r	8	8
Snowball	b	9.2	" 24..	" 9.	" 22.	9	m	l c	b s	8.5	9
Sparta	b	9.2	" 26..	" 7.	" 24.	8.5	s m	l c	d c	9.5	9.5
Splendid	b	9.2	" 24..	" 9.	" 24.	8.8	m	d c	d s	9	9
Stahelin	p	9.5	" 24..	" 5.	" 26.	9.4	l	r c	v d c	9.5	8
Staples	b	8.8	" 23..	" 5.	" 24.	7	s	l c	v d c	9	8.5
Star	b	9	" 24..	" 8.	" 22.	8.5	l	b c	b s	9	8
Stevenson	p	9.5	" 26..	" 9.	" 24.	8.8	s	r c	d c	9.5	8
Stone	p	9.2	" 23..	" 5.	" 20.	9.1	m l	l c	b s	8.8	8
Success	b	9.2	" 24..	" 10.	" 24.	8.8	l	b c	b d s	9.5	7.5
Sunnyside	p	9.5	" 26..	" 7.	" 22.	8	l	r c	l s	8.5	8
Sunrise	p	9.8	" 26..	" 8.	" 22.	9	s m	r c	b s	8.5	8.5
Thompson No. 103	b	9.5	" 23..	" 9.	" 22.	4	l	r c	v b c	9	9
Timbrell	p	7	" 27..	" 12.	" 27.	9.4	l	r c	v d c	9	8
Tubbs	b	9	" 26..	" 8.	" 21.	8.8	m	r c	b c	9	7.5
Unnamed	b	9.4	" 26..	" 10.	" 24.	8.8	v l	b l c	b d s	9.4	8.8
Van De Mark	p	7	" 26..	" 9.	" 23.	7	m	r c	d c	10	9
Vandervort No. 1	b	6	" 26..	" 8.	" 21.	5	m l	r d c	b s	9.5	7
Vandervort No. 2	b	9.3	" 24..	" 7.	" 24.	9	m	b c	b s	9.8	8
Vandervort No. 3	p	9.3	" 23..	" 6.	" 24.	8.6	l	b c	d s	8.5	8
Vera	p	8	" 27..	" 9.	" 21.	8.5	m	r c	d c	9.8	8
Warfield	p	9	" 24..	" 8.	" 23.	9.2	m	l c	d c	8.5	9
Western	p	6	" 26..	" 8.	" 26.	9	l	b c	b c	8	8.5
Wetzell	b	9.5	" 26..	" 6.	" 24.	8	m l	r c	l s	8	7.5
Whitney	b	8	" 26..	" 9.	" 22.	8.5	l	......	b s	8.5	8
Wm. Belt	b	9	" 27..	" 10.	" 26.	9	l	l c	l c	8.5	9
Woolverton	b	9	" 26..	" 10.	" 24.	8.8	m	l c	d c	8	9
World's Champion	p	8.8	" 24..	" 5.	" 22.	7	m	b c	d c	7.8	8
Wyatt	b	9.3	" 26..	" 6.	" 21.	7	m	r c	d c	9.5	8.5
Zula	b	5	" 26..	" 10.	" 21.	5	s	l s	d b c	8.5	8.5

NOTES ON VARIETIES.

The following sorts fruited here for the first time during the past season:

Anlo.—Plants received from A. D. Leffel, Anlo, Ohio. Imperfect flower. The plants are of fair growth and healthy in foliage but do not make many runners. Berries large in size, form broad conical, depressed, often irregular and ridged. The color is dull, dark crimson. The irregular form and dull color are against it.

Armstrong.—Plants from Birdseye & Son, Middle Hope, N. Y. Perfect flower. The plants are of very strong growth and the leaflets large, dark green and healthy. One of the best varieties in plant qualities. Berries large, broad conical in form, usually with short neck: color light scarlet; flesh light, lacking in juice and rather soft in texture. The fruits are often irregular in form, the color is too light and they are not firm enough for market. The large size of the berries held out to close of season.

Arnout. From C. W. Graham, Afton, N. Y. Perfect flower. The plants are not of strong growth and the variety is not a good plant maker; foliage, light green. Berries small to medium in size, form broad conical, with neck; bright, dark scarlet, very attractive in color; the flesh is dark, juicy, quite acid in flavor, with a texture sufficiently firm to stand shipment well. The plants are very productive but set so much fruit that most of the berries are too small to sell well.

Berry.—Imperfect flower. The plants are scattering but the individual growth is strong and the foliage healthy. Berries medium in size, short, round conical in form, and dark crimson in color; the flesh is dark, juicy, of good quality and firm. Requires further trial to determine plant qualities.

Bethel.—Plants received from H. W. Shockey, Donnelsville, Ohio. Imperfect flower. Plants of good growth and healthy in foliage. Berries medium in size, round or broad conical in form and dark crimson in color; the flesh is dark, juicy and of high quality. The fruit is very attractive in appearance, but too small in size, and the plants are scarcely productive enough.

Brownie.—Received from LeRoy N. Brown & Sons, Clyde, Ohio. Perfect flower. Plants strong growing and healthy in foliage. Berries medium to large in size, usually round conical, sometimes broad conical, in form; bright, light scarlet color, flesh juicy and aromatic in flavor. Holding out well in season, but the fruits are not large enough to make the variety one of special merit.

Chenango.—Plants received from C. W. Graham. Perfect flower. Plants are not of strong growth. Berries medium in size, of round conical form and light scarlet color. The flesh is light in color, juicy, and quite acid. The fruit is too small in size, too light in color and the quality is low.

Darling.—Received from E. J. Hull, Olyphant, Pa. Perfect flower. Plants of strong growth but make few runners. Berries small in size, round conical and regular in form; flesh dark, rather mealy in texture, but of good quality. As grown here this season, the plants were unproductive and the berries small.

Drought King.—From W. F. Allen, Jr., Salisbury, Md. Imperfect flower. Plants vigorous in growth and healthy in foliage. Berries medium in size; form round conical, depressed; color dark scarlet. The flesh is dark, juicy, and sour. The plants are very productive, the fruits even and regular in form, but are too small in size to sell well.

Excelsior.—From L. J. Farmer, Pulaski, N. Y. Perfect flower. The plants are very vigorous and healthy in growth and foliage. Berries large, long conical, or pointed round conical in form, and a bright scarlet color. The flesh is bright, juicy, of fair quality and firm. This variety was the first to ripen fruits and the plants were productive. The season was shortened by the dry weather and the last fruits were small. A very promising early berry.

Flash.—Plants received from E. J. Hull. Imperfect flower. Plants of rather weak growth and no runners made, though healthy in foliage. The berries are large in size, the form is broad, short conical, somewhat irregular, and the color dark crimson. The flesh is dark, juicy, of high quality and firm. If the plants prove stronger growers, it will be an excellent sort.

Garringer.—Plants from E. J. Hull. Perfect flower. The plants are not of strong growth and did not make runners freely. Berries large, broad, coxcombed in form; color, dark crimson; flesh dark, juicy, of fine quality and firm. The variety is excellent in fruit and the plants were productive for the growth.

Heffin No. 3.—Received from C. W. Graham. Imperfect flower. Plants of strong growth and the foliage is healthy. Berries small to medium in size; short depressed

conical, often irregular in form. The flesh is bright, juicy, of high quality and firm. The high quality of the fruit seems to be the only point of special merit.

Henry.—Plants from American Gardening Co., New York City. Perfect flower. Quite unproductive and in no way satisfactory. The variety as grown here was weak in growth, and did not as closely resemble Marshall as is claimed by many persons.

Hunn.—Plants received from Wm. D. Barns and from Birdseye & Son, Middle Hope, N. Y. Imperfect flower. Plants are of fair growth and the foliage is dark green and healthy. Berries large in size, pointed, round conical in form and dull, dark scarlet in color; flesh bright red, and of good quality and firm. Many fruits failed to develop and the plants blighted quite badly at the close of season.

Ima.—From LeRoy N. Brown & Sons. Imperfect flower. Plants of weak, scattering growth, with very few runners. Berries small, round conical, often imperfect in form, firm. Plants blighted at close of season. Nothing in plant or fruit to specially recommend the variety.

Lady Franklin.—Plants from Harry G. Wolfgang, Salem, Ohio. The plants are of strongest growth, foliage very large, thin and papery in texture, and healthy. Berry large, quite long or broad conical in form, and dark crimson in color. The flesh is bright, juicy, of high quality, but soft. The variety is one of the best in plant qualities, and the fruit is attractive, of good form and best quality, but too soft for shipment. The plants are but moderately productive. A good home berry.

Lehigh.—Received from W. F. Allen, Jr. Imperfect flower. Plants are scattering. Berries small to medium size, bright, dark scarlet color. Not promising in plant or fruit.

Magoon.—Plants from Matthew Crawford, Cuyahoga Falls, Ohio. Plants of weak growth and made no runners; foliage small and appears unhealthy. A few imperfectly formed fruits, dark in color and of high quality, borne. Of little value from this season's showing.

Margaret.—From Matthew Crawford. Perfect flower. Plants are of good growth, though not strong runner makers. Berries are very large, broad conical form and of a dark crimson color. The plants are productive, the fruits among the largest in size, attractive in appearance, the quality is good and they are firm enough to stand shipment well. A valuable variety.

Marguerite.—Plants from J. C. Grossman, Wolcottville, Ind. Imperfect flower. The plants did not make a good growth and but few fruits were formed. Further trial is necessary before reporting.

Maximus.—Received from J. H. Hale, South Glastonbury, Conn. Perfect flower. The plants are not of strong growth and the foliage has an unhealthy appearance. Berries medium in size, long conical form and of dark crimson color. The fruits are attractive in color and of high quality. Lacking in plant vigor and productiveness.

Mele.—From Matthew Crawford.—Imperfect flower. Plants of good growth and healthy in foliage. Berries large, round conical, regular form; bright, dark crimson color; very attractive in appearance. The flesh is bright, juicy, of good quality and firm. Excellent in berry, and if more productive would be a valuable variety.

Milton.—Received from Matthew Crawford. Perfect flower. Plants are of small growth. Berries of medium size, long, broad conical form and dark crimson color. The berries are too long for good form and the color is rather dull; the quality is high but the plants are scarcely productive enough to make the variety a valuable one.

Nick Ohmer.—Plants received from Matthew Crawford. Perfect flower. Plants are of good appearance, though not of strongest growth. Berries large, ovate conical in form and a bright crimson color. The flesh is bright, of good quality and firm. The large size, fine appearance, high quality and firmness of the fruit promise much for this variety. The plants were in a poor location and were not as productive as may be hoped for under better conditions.

Nina.—From Jos. H. Black & Sons, Hightstown, N. J. Perfect flower. The plants are of good growth and excellent in foliage. Berries medium to large in size, round conical form and a bright scarlet color. The flesh is dark, of good quality and moderately firm. The variety is good in plant qualities and moderately productive.

Orewiler.—From Henry Orewiler, Shelby, Ohio. Perfect flower. Plant of strong growth, though the foliage has an unhealthy appearance. Berries large; form, ovate conical, usually with neck; color, an attractive crimson. The fruit is of high quality, but the plants are scarcely productive enough.

Parker Earle Jr.—Received from T. C. Kevitt, Athenia, N. J. Perfect flower. A careful comparison of this variety with Parker Earle growing by the side failed to note any difference in plant or fruit.

Pet.—Plants from E. J. Hull. Perfect flower. The plants are of fair growth and the foliage is healthy. Berries are of medium size, long or broad conical form and dark

crimson color. The flesh is juicy and of a very rich aromatic flavor. The berries do not color well on tips or under side, and are often irregular in form. Valuable for the high quality of the fruit.

Phoenix.—Received from Slaymaker & Son, Dover, Delaware. Perfect flower. The plants are of medium growth, some much stronger than others. Berries medium in size, round conical form and dark scarlet color. Many fruits formed that did not develop. The variety seems to possess no points of special merit.

Ponderosa.—From C. W. Graham. Perfect flower. Plants of good growth and excellent in foliage. Berries of large size, round or broad conical form, often somewhat ridged; color a very dark, rich crimson. Flesh dark, juicy, of very good quality and firm. The variety is valuable for the size, color, quality and firmness of the fruit, and the plants are productive, but not of strongest growth.

Pride of Ohio.—Received plants from W. H. Earhart, Lexington, Ohio. Perfect flower. Plants of very strong growth and excellent in foliage. Berries of medium size, round conical or often irregular in form and of an attractive bright scarlet color. The flesh is dark, rich, juicy, of high quality and firm. Many blossoms failed to set and develop fruits, and the early promise of a large crop was not fulfilled. Excellent in quality and appearance of fruit.

Sample.—Received from Ohio Experiment Station, Wooster, Ohio. Imperfect flower. Plants very strong in growth and have a healthy, dark green foliage. Berries large, round or broad conical form and a very dark, rich crimson color. The flesh is dark, rich, juicy, and of very good quality and firm. The excellent plant qualities of this variety, its productiveness, and the fine form, handsome appearance and high quality of the fruit make this one of the most promising of the new sorts tried this year.

Seriver.—From J. D. McCrimmon, St. Louis, Mich. Perfect flower. Plants of strong growth and healthy foliage. Berries medium in size, form long conical with neck; color a dull, dark crimson. The flesh is a bright red, somewhat mealy but of good quality. The berries lack size and the plants were unproductive after the first pickings.

See No. 1.—Plants received from H. S. & A. J. See, Geneva, Pa. Perfect flower. Plants of fair growth but not making runners freely. Berries small in size, of round conical form and bright scarlet color. The flesh is bright, juicy, quite acid in flavor, and firm. The fruits are too small.

See No. 2.—From H. S. & A. J. See. Imperfect flower. The plants are of very strong growth and excellent in foliage. Berries medium to large in size; pointed, long conical in form, and bright, dark scarlet in color. The flesh is bright, juicy and of good quality. The variety is one of the best in plant growth and productive; the berries are usually of fair size, good in form and color and will sell well in market, though most of the fruits have a hard core.

See No. 3.—From H. S. & A. J. See. Imperfect flower. Not so good in plant growth, but the berries are larger, of better form and more attractive in color than No. 2. Productive. A very promising sort.

See No. 4.—From H. S. & A. J. See. Imperfect flower. Plants very strong, healthy and productive. Berries very large, broad, conical, often ridged in form, and of a bright, light scarlet color. The flesh is light in color, but bright, juicy and of fair quality. Valuable for its plant qualities, productiveness and large size of the fruits. Not so good in form, color or quality of fruit as No. 3.

Seek-no-further.—Plants from Jos. H. Black & Son. Perfect flower. Plants of very strong growth and the foliage is healthy. Berries of large size, round conical, regular form and a light scarlet color. Flesh, light, juicy, of fair quality and moderate firmness. Plants are scarcely productive enough. The variety seems to possess no points of special merit.

Seneca Chief.—Received from Slaymaker & Son. Perfect flower. Plants of good growth and healthy in foliage. Berries small to medium in size, depressed round conical form and dark scarlet color. Flesh dark, of very high quality and firm. Valuable for the high quality, good form and fine appearance of the fruit; but the berries are too small and the plants were but moderately productive.

Success.—From Slaymaker & Son. Perfect flower. Plants are of very strong growth and the foliage is large, dark green and healthy. Berries large, broad conical form and of a very bright, dark scarlet color. Flesh dark, not juicy, but of good quality; rather soft. The fruits are of good form, attractive in appearance, of high quality, but lacking in firmness. The plants are but moderately productive.

Van DeMark.—Received from E. Van DeMark, Clinton, Mich. Imperfect flower. Plants are of rather small growth and are not making runners freely. Berries of medium size, short, round conical form and dark crimson color. Flesh dark, aromatic,

and of very high quality. The variety is excellent in berry, but requires further trial for plant growth and productiveness.

Vandervort No. 1.—Plants from J. H. Vandervort, Hudson, Mich. Perfect flower. Plants are not of strong growth, though the foliage is healthy. Berries medium to large in size, round depressed conical form, and bright scarlet color. Flesh dark, of good quality, but soft. The plants are unproductive.

Vandervort No. 2.—From J. H. Vandervort. Perfect flower. The plants are of good growth and excellent in foliage. Berries of medium size, broad conical form, usually with neck; color a very bright, attractive scarlet. Flesh bright, juicy, of good quality and moderately firm. The plants are quite productive and the high quality and attractive color of the fruit are points of merit.

Vandervort No. 3.—From J. H. Vandervort. Imperfect flower. One of the best varieties in plant and foliage. Berries large size, long, broad conical form and a dull, dark scarlet color. Flesh dark, juicy, quite acid flavor. No points of special merit.

Vera.—Plants from E. B. Stevenson, Freeman, Ontario. Imperfect flower. The plants are of fair growth and have a healthy foliage. Berries medium in size, round, pointed conical form and a dark crimson color. The flesh is bright in color and has a rich aromatic flavor. The fruit is very high in quality, otherwise the variety has no points of special merit.

NEW VARIETIES OF 1898.

The following were quite fully described in the report of last year:

Arkansas Traveler.—The plants were of more vigorous growth than last season and moderately productive. The berries are large and of good form and color. The variety has no points of special prominence.

Avery.—A variety of the Haverland type, excellent in plant and fruit.

Bismarck.—The berries are uniformly large in size and of good color and form. A desirable variety to grow under high culture for large fancy fruits.

Bryant.—This variety made an excellent showing again the past season. The plants are very strong growing and productive; the fruit large, attractive in appearance and firm. The quality is low, but it is an excellent market sort.

Burnett.—Stronger in plant than last season. Valuable for the high quality and attractiveness of the fruit. The plants are but moderately productive.

Cobden Queen.—Excellent in plant growth and the berries are large, but are often hollow and lack quality and firmness.

Dollar.—Good in plant growth and the fruits rank high in quality and appearance. The berries were not so large as those produced last year, and the plants are not productive.

Evans.—The plants in hills produced larger fruits and the season was much longer than on the plants in the matted row.

Fountain.—The plants are productive, and the attractive appearance, high quality and firmness of the fruit make it a valuable variety for home use or for market.

Hatch Experiment Station.—Nothing special in plant or fruit.

Herbst.—The plants were unproductive the past season and lacking in vigor of growth.

Hilton Gem.—The plant growth was not so strong as last year, and the variety is not productive enough to make it valuable.

Hood River.—The variety ranks well in plant growth and fruit qualities. If the berries were larger it would be a valuable sort for market or home use.

Hoosier.—One of the best of last year's sorts and the variety has made an excellent showing this season. The berries are large, attractive, of high quality and firm, and the plants are productive. A variety well worthy of extensive trial for home use or for market.

Howell No. 2.—Made a poor showing this season. The plants were of weak growth and the fruits imperfectly formed.

King Worthy.—The plants were more productive than last season. The fruits are large and hold out well in size to close of season. The light color of the berry and its lack of firmness are against it.

Knight.—Not making quite so good a showing as last season, but still a variety of much promise.

Little No. 7 and Little No. 8.—While these sorts have merit in the attractiveness, quality and firmness of berry, the size of the fruits and the productiveness of the plants are not such as to give them special prominence.

Little No. 40.—The variety was not so productive as last season, but the large size of the berry, its attractive appearance, good quality and firmness of flesh promise much for it as a market sort.

Manwell.—Not so satisfactory in plant or fruit as last season.

Mayflower.—One of the most vigorous in plant growth and productive for an early ripening sort. Likely to prove valuable as an early market berry.

McKinley.—This season's showing in plant or fruit was not such as to make the variety one of special prominence.

Michigan.—The variety is not of strong plant growth, otherwise a valuable late ripening sort.

Mineola.—Again this variety has shown itself to be of little value as grown here.

Morgan Favorite.—Strong in plant growth, healthy in foliage and productive. The large size, good form, high quality and firmness of the berry make this a valuable market sort.

Omega.—The plants were not so strong in growth as last season, though more productive. In attractive appearance and quality of the fruit the variety ranks high. Seems well adapted to hill culture.

Patrick.—Excellent in plant qualities, but the fruits are too small.

Peabody.—Productive, and the plants are strong in growth and healthy in foliage. The berries are small, poor in quality and lack firmness.

Pet.—The plants are not productive enough. The berries are of high quality and firm, but are too small.

Pride of Cumberland.—The berries are large, but often hollow. Many of the last fruits on the plants failed to develop.

Ridgeway.—Excellent in growth and among the first in productiveness. The berries are large, very attractive in appearance, of high quality and firm. Seems well worthy of extensive planting for home use or for market.

Satisfaction.—The fruits are very high in quality, but are usually too small to sell well. The plants are but moderately productive.

Star.—Seems to have no points of special prominence.

Stevenson.—Made a much better showing than last season.

Stone.—An early ripening sort, well worthy of extensive trial.

Unnamed.—An excellent variety to grow in hills for large fruits.

Wetzell.—Vigorous in plant growth, but not productive enough.

Whitney.—Made a better showing than last season, but many of the fruits are imperfectly formed.

World's Champion.—Not of much merit in plant or fruit as grown here.

The following are among the older and better known sorts that have been grown for several seasons:

Beder Wood.—The plants are often troubled with blight and the berries are rather soft, and light in color. It is a popular variety for fertilizing the pistillate sorts.

Brandywine.—A rather late ripening sort, bearing large fruits that are of good form, color and quality. One of the best large fruiting sorts to grow for home use or for market.

Bubach.—A popular large fruited sort especially adapted to strong soils.

Clyde.—The plants are very productive and the berries large, but rather light in color. On soils not easily affected by drought it is one of the best fertilizers for the pistillate sorts.

Crescent.—Once a very popular variety, but now being superseded by larger fruiting sorts.

Enhance.—A well known sort, quite largely used as a fertilizer.

Glen Mary.—Excellent in plant growth. The fruits are large and good in form, color and quality. One of the most promising sorts for market.

Greenville.—An excellent sort for home use or near market. The fruits are hardly firm enough to ship well.

Haverland.—A very productive sort and the fruits are of good quality. One of the most profitable varieties to grow, but the fruits are scarcely firm enough to stand distant shipments.

Ideal.—Good in plant and the berries are of fine form, good color and high in quality. Worthy of trial for home use and for market.

Leroy.—A variety not widely known. The plants are of strong growth and productive of large-sized fruits that are of good color, high quality and firm. A good market berry.

Lovett.—In some localities largely used as a fertilizer for pistillates and as a market sort, for canning purposes.

Marshall.—One of the best large fruiting sorts to grow for market. The foliage is quite likely to rust, unless grown on strong, moist soils.

Parker Earle.—A good late market sort on strong, moist soil.

Purdue.—A variety worthy of trial as a market sort. It has a long season and the fruits hold out well in size.

Timbrell.—A good variety to grow for home use. Its color is against it as a market berry.

Warfield.—The fruits are not so large as those of some other sorts, but the plants are very productive, and the dark, rich color of the berries make it one of the best sellers on the market as a variety for canning.

Wm. Belt.—One of the large fruited sorts that is making an excellent showing as a market berry.

SUMMARY OF VARIETIES.

The most promising of the new sorts are: Excelsior, Flash, Lady Franklin, Nick Ohmer, Ponderosa, Sample, See No. 3 and No. 4.

Of the varieties that have been grown for two seasons the following have made the best showing: Bryant, Fountain, Hoosier, Knight, Morgan Favorite and Ridgeway. Bubach, Haverland, Lovett and Warfield, with Beder Wood, Sharpless or Clyde as fertilizers, still have a place as money making sorts.

If fancy fruit under intensive culture is the object of the grower, he will find in Brandywine, Glen Mary, Marshall and Wm. Belt sorts well worthy of his attention.

Mayflower as an early berry and Michigan for late are worthy of trial for the purpose named.

AGRICULTURAL COLLEGE, MICH.,
August 1, 1899.

SOUTH HAVEN REPORT FOR 1899.

BY S. H. FULTON.

Bulletin 177.—Horticultural Department.

Prof. L. R. Taft, *Horticulturist:*

Sir—The following account of the work of the South Haven sub-station for the year 1899 is herewith submitted. The effects of the severe winter of 1898 and 1899 were not so serious as anticipated and most kinds of fruit made a good showing this season. Peaches, blackberries and strawberries were more or less damaged, but other fruits suffered little if any injury. The past season has been a most favorable one for plant growth and for repair in case winter injuries were sustained. Trees of all kinds have made a good development of new wood. This new growth, although stronger and more vigorous than usual, has ripened well and the trees this fall are apparently in good condition for winter. After cultivation was stopped in summer, the orchards were seeded with crimson clover, while grapes and small fruits were sown with oats. A very good stand of clover was secured except for a small part of the last seeding which failed because of the occurrence of a spell of hot dry weather before the plants had become well established. The oats have grown vigorously and will afford a good cover for the ground during the winter. Operations in spraying, pruning and fertilizing as carried on this year are briefly reviewed, together with the results of some experiments undertaken in these and other branches of the work. Tabulations, including the names of varieties which fruited this season, with records of the time of blooming and ripening of the different kinds, productiveness, weights of specimens, etc., are given as in former reports. Quite a large number of sorts, mostly new kinds, are also given more extended mention by way of notes on varieties.

STRAWBERRIES.

Strawberries have been grown at the South Haven sub-station since it was established ten years ago. When the trees were small, it was the custom to set strawberry plants received for trial between the rows; but as they became larger this practice was discontinued and the last planting was made on ground left vacant by the removal of a number of varieties of bush fruits. This plantation, having been fruited two years, was plowed under shortly after the last picking of berries was made this season, and the plat will again be set with bush fruits. The grounds are now so well filled with fruits of other kinds that no really suitable place for a new plantation of strawberries is available, and for this reason it has been thought best to discontinue further tests of this fruit at the sub-station.

Owing to unfavorable conditions, the yield of strawberries was quite unsatisfactory this season. As the plants rarely winter-kill in this section, no mulch was provided last winter for their protection. But owing to the unusual severity of the weather to which they were subjected, a large number of varieties killed out badly and many of the surviving plants were so injured that they could not properly mature their fruit. Hot dry weather during the latter half of June brought the fruiting season to a close several days earlier than usual. However, in spite of these unfavorable conditions, some varieties made a very creditable showing; and while in many instances the following tabulation and notes do not represent the true value of varieties under usual conditions, still the record of results obtained may have worth as indicating some of the most reliable sorts.

Among the more productive early varieties were Earliest, Early Jack, Lincoln, Patrick and Stone. Lincoln is a conical, dark scarlet berry of fair quality. It has been on trial here since 1891, and has not failed to yield well. Patrick lacks somewhat in quality and appearance, but is very productive and is considered worthy of trial as an early market variety.

Among the late and medium late varieties, La Crosse, Odessa, Omega, Ridgeway, Sam Sperry, Timbrell and Tonga gave very satisfactory yields. On the whole, Omega was one of the very best of the late varieties this season. Ridgeway is an attractive berry of good quality and is promising as a medium late home and market sort. Timbrell, in addition to being productive, possesses considerable vigor of plant, but the fruit is rather unattractive in appearance.

The following are descriptions of varieties which fruited here last season for the first time, but which were not described in the sub-station report of last year. Several are varieties originated by crossing a number of well known kinds and were named by uniting the names of the parents. They were received in 1897 from the originator, W. W. Sewall, of Carthage, Mo. The plants were in poor condition when received and fruited very sparsely last year, but this season they had become well enough established to give some indication as to their worth. Several of them seem to have merit both for home use and market.

TABULATION OF STRAWBERRIES, 1899.

ABBREVIATIONS—p, pistillate; b, bisexual; c, conical; co, compressed; i, irregular; l, long; o, oblate; ob, oblong; r, round; b, bright; c, crimson; d, dark; l, light; s, scarlet.

SCALE—1 to 10; 1, feeble; 10, very vigorous.

Name.	Sex.	Vigor (1-10).	Date bloom.	Date first picking.	Date last picking.	Productiveness scale (1-10).	Form.	Color.	Quality (1-10).	Texture (1-10).	Weight (oz).
Acem	b	7	April 29	May 29	June 12	3	r c	l s	5	6	.16
Arkansas Traveler	b	6	May 2	June 7	" 17	5	c co	d s	5	7	.2
Arrow	p	8	" 3	" 9	" 17	1	l c	d c	6–7	8	......
Auburn	p	6	" 6	" 7	" 14	4	c co	d c	7–8	8	.16
Avery	p	7–8	April 29	" 5	" 20	6	l c	d s	7	7	.25
Beauty	b	5–6	" 29	" 3	" 17	9	r o c	b s	6–7	7	.25
Beecher	b	7	May 2	" 9	" 17	5	r	d c	7–8	6–7	.2
Belt 3	b	9	" 1	" 7	" 20	8	c co i	s	7	8–9	.33
Beverly	b	9–10	" 1	" 5	" 20	8	c co	b c	8–9	8–9	.5
Bob Bubach (3353)	b	8	" 2	" 7	" 21	8	c co	s	7	8–9	.33
Brandywine	b	6	" 3	" 9	" 20	1	r c	d c	9–10	8–9	......
Brunette	b	6	" 4	" 9	" 20	2	r c i	d c	9	9	.25
Bubach 5	p	8	" 2	" 7	" 22	9	c co	s	6	5	.5
Carnot	b	6	" 4	" 16	" 22	9	c i	b s	6	7–8	.2
Carrie	p	8	" 1	" 8	" 20	6	c co i	b c	6	7	.25
Carrie Crescent	p	10	" 1	" 8	" 26	7	c co	b c	6–7	7	.33
Chairs	b	6	" 1	" 7	" 20	8	r ci	l s	4–5	5	.25
Champion	b	8	" 1	" 7	" 21	7	l c i	s	3	4–5	.5
Charlie Crescent	b	7	" 1	" 5	" 22	7	c co i	c	6	6	.2
Charlie	p	8	" 1	" 6	" 23	8	c co	s	6–7	6	.2
Cheyenne	p	6	" 4	" 9	" 21	1	i	s	7	6	......
Cobden Queen	p	7–8	" 1	" 7	" 20	7	c co	s	8	7–8	.25
Columbia	b	5	" 1	" 11	" 17	8	c co	s	8	7–8	.2
Columbian	b	4–5	April 29	" 5	" 21	6	r c	l s	5–6	7	.2
Crescent	p	8	" 29	May 31	" 20	10	r c	s	5–6	6–7	.2
Cruse	b	6	May 2	June 7	" 22	8	co i	b d s	7	9	.33
Curtis 15	b	7	April 29	" 5	" 24	7	l c co	l s	5–6	4–5	.25
Curtis 159	p	9	May 2	" 3	" 20	8	c i	l s	5–6	7	.33
Cyclone	b	5	" 1	" 5	" 17	5	l c	c	8–9	8	.2
Daisy	p	7	" 1	" 9	" 21	7	c co i	b c	9	7	.25
Dan Bisel	b	4–5	" 2	" 7	" 20	7	c i	b s	8	8	.2
Dayton	b	4	" 2	" 7	" 17	6–7	c co	l s	5	8	.2
Delia	p	4–5	" 6	" 9	" 20	8	r c co	s	8	7	.25
Dollar	b	3	April 29	" 7	" 22	6–7	c i	s	7	8	.2
Earliest	b	8	" 29	May 29	" 14	7	r c	l s	7	8	.2
Early Jack	b	4	" 29	June 2	" 17	9	r o i	b s	2	6	.2
Edgar	p	8	May 1	" 7	" 22	8	i	l s	4	5–6	.25
Edwards	b	5–6	" 1	" 7	" 23	3	c co i	d s	7	7	.2
Edwards (Fav.)	b	3	" 3	" 10	" 20	7	c co	d s	6–7	8	......
Eleanor	b	5	" 1	" 3	" 20	7	r o c	c	7–8	6	.2
Enhance	b	5	" 4	" 2	" 20	6	o c	b c	8	9	.25
Epping	p	6–7	" 3	" 7	" 20	6	c i	s	7	7	.25
Eureka	p	6	" 2	" 12	" 17	4	i	l s	7–8	9	.33
Evans	b	4	" 1	" 7	" 22	4	r c	s	7–8	7	.2
Faux	b	7	" 1	" 7	" 21	7	co	d s	7	8	.16
Fifer	b	8–9	" 1	" 7	" 22	8	c co i	l s	6	7	.16
Fir	b	7	" 1	" 8	" 17	7	c co i	b c	8	7	.25
Fountain	b	4	" 1	" 8	" 17	5	c co	b c	5	5	.25
Fremont	b	7	" 1	" 7	" 20	4	r c co	c	7	7–8	.2
Gardner	b	6	" 1	" 5	" 20	7	c co	d s	5	6	.25
Giant	b	5	" 1	" 5	" 17	5	i	s	6–7	6–7	.25
Gipsy	p	6	" 2	" 3	" 17	4	c co	b d c	8	8	.25
Greenville	p	7	" 2	" 7	" 17	6	c co	d s	9	8	.2

TABULATION OF STRAWBERRIES, 1899.—CONTINUED.

Name.	Sex.	Vigor (1-10).	Date bloom.	Date first picking.	Date last picking.	Productiveness scale (1-10).	Form	Color.	Quality (1-10).	Texture (1-10).	Weight (oz).
Haights	b	5-6	May 1	June 5	June 20	8	r c	s	5	8	.16
Hattie Warfield	p	8	" 1	" 5	" 20	9	c co	d s	7-8	9	.25
Haverland	p	7	" 1	" 2	" 17	7	l c co	s	8	8	.33
Hersey	b	5	" 1	" 7	" 17	2	r c	d s	7-8	7	.12
Holland	p	9	" 1	" 5	" 20	6	c i	s	3-4	6	.25
Homestead	b	6	" 2	" 7	" 17	4	c co	d s	7	6-7	.14
Hood River	b	5	" 6	" 15	" 20	2	r o b	s	6	6-7	......
Hyslop	b	3	April 29	May 31	" 17	2	r c	d s	8	9	.1
Ideal	b	7	May 1	June 2	" 20	2	r c	c	5	9	.14
Irene	p	7	April 29	" 7	" 23	9	r c	b c	6-7	7-8	.12
Kansas	b	6	May 1	" 3	" 20	7	r c i	b d s	7	8	.33
Kennedy (Anna)	p	6	" 2	" 3	" 20	5	r o	l b s	9	9	.2
Klickita	p	7-8	" 2	" 9	" 21	8	r c co	l s	7-8	4	.2
King Worthy	b	6-7	" 2	" 5	" 22	7	c co	d s	6-7	5	.4
Knight	b	6	April 29	" 2	" 17	8	c co i	b s	3-4	7-8	.33
La Crosse	b	7	May 2	" 12	" 24	7	c co i	l s	6-7	7	.2
Lanahan	b	3	" 6	" 9	" 17	1	l c	s	7	9	.11
Laxton No. 1	b	5	" 1	" 9	" 15	3	c co	b c	7-8	8	.12
Lehigh	p	8	" 1	" 3	" 20	9-10	r c i	d s	5	7	.2
Leroy	p	6	" 1	" 5	" 17	3	r c	c	7	8	.25
Lincoln	p	8	April 29	May 29	" 20	8-9	c i	d s	6	5-6	.2
Little 42	b	7	May 1	June 2	" 20	6-7	c co i	l s	6-7	6	.33
Longfield	p	7	" 2	" 7	" 17	8	c	l c	8	7	.16
Mamie Warfield (606)	p	8	" 2	" 5	" 20	8	r c	s	7-8	9	.25
Manwell	b	5-6	" 6	" 7	" 20	7	i	d c	6	8-9	......
Margaret	b	6	" 2	" 1	" 17	8	c co	b c	8	8	.25
Marshall	b	6	" 1	" 9	" 17	1	c co i	b c	8	8	......
Mary	p	4-5	" 1	" 7	" 21	8	c i	c	7	8	.2
Maybrott	b	7	April 29	" 3	" 17	8	r c i	d c	5-6	6	.25
Mayflower	b	8	May 1	" 5	" 20	7	r c	l s	7-8	9	.2
Meeks	b	7	" 1	" 3	" 17	2	r c	d c	7-8	8	.16
Minneola	b	4-5	" 6	" 12	" 24	3	i	s	8	8-9	.2
Murray	p	3-4	" 4	" 12	" 20	4	i	d s	6	8-9	.14
Noble	b	5	" 4	" 12	" 20	7	i	c	8	7	.33
No Name	b	9	" 4	" 12	" 22	5	c co i	l s	7-8	7-8	.25
No. 7	b	5-6	" 1	" 12	" 23	7	c co	l s	7	8-9	.12
No. 8	b	10	" 2	" 12	" 21	8-9	i	l s	8	8	.33
No. 40	p	6-7	" 2	" 12	" 21	8	i	l s	7-8	8	.25
No. 1000	p	3	" 3	" 9	" 20	5	c co	b c	7	7	.25
Ocean City	b	4	" 4	" 12	" 23	4	i	s	6-7	7-8	.25
Odessa	b	7	" 4	" 12	" 24	8	c co i	l s	5	8	.2
Omega	p	8	" 4	" 7	" 25	10	c i	d s	7	8	.2
Ona	p	7	April 29	" 3	" 17	4	r c	d s	5-6	8-9	.2
Orange Co.	p	7	May 1	" 5	" 20	7	o co	l s	6-7	8	.2
Oregon	b	5	" 1	" 8	" 21	8	c co	s	7	8	.2
Oriole	p	6	" 1	" 5	" 17	6	l c co	b c	7-8	8	.25
Orono	p	8	" 2	" 7	" 21	7-8	r c co	b c	8	7-8	.2
Ostego	p	8	" 2	" 7	" 22	7	c i	b c	7-8	8	.2
Paris King	b	3-4	" 2	" 7	" 21	2	c co	l s	4-5	6	.2
Patrick	b	7-8	" 1	May 31	" 17	9	c co	s	6	8	.2
Peabody	b	6-7	" 1	June 8	" 20	6	c co i	b s	6	4-5	.2
Perfection	p	7	" 2	" 8	" 21	8	i	s	10	8	.33
Pet	b	5	April 29	" 7	" 17	6	i	c	7	7-8	.25
Phipen	b	7	May 1	" 7	" 17	4	r c	c	7-8	7	.12
Plow City	b	4-5	" 2	" 12	" 20	1	i	l c	6	7	.25
Polly Warfield	p	7	" 2	" 7	" 21	8	r c	l s	7-8	8-9	.2
Pride of Cumberland	b	4	" 2	" 7	" 20	3	c i	d s	7	6	.16
Princeton	b	7	" 1	" 7	" 21	7	r c i	l s	6	7	.2
Ridgeway	b	7	" 4	" 12	" 20	8	c co	d s	8-9	8	.25
Richmond	b	4-5	" 2	" 12	" 21	4	c co	c	8	7	.16
Riehl	b	4	" 2	" 12	" 17	3	c co i	c	8	8-9	.2
Rob Rusk	b	7	April 29	" 2	" 14	2	l c co	c	8	8-9	.2

TABULATION OF STRAWBERRIES, 1899.—CONCLUDED.

Name.	Sex.	Vigor (1-10).	Date bloom.	Date first picking.	Date last picking.	Productiveness scale (1-10).	Form.	Color.	Quality (1-10).	Texture (1-10).	Weight (oz).
Sam Sperry	b	9	May 4	June 12	June 24	7	c co	s	7	9	.25
Sandoval	b	7	" 1	" 7	" 24	7	r c i	c	6	7–8	.2
Satisfaction	b	3	" 1	" 8	" 20	2	c co	b s	7	7	.16
Saunders	b	7	" 6	" 10	" 20	7	c co i	d s	9–10	9	.2
Shawnee	b	3–4	" 2	" 12	" 17	4	c co i	c	7	6	.2
Sherman	b	7	" 1	" 3	" 21	10	r o	b s	5	7–8	.5
Shyster	p	4	" 1	" 3	" 20	7	r co i	d s	6–7	5–6	.5
Smalley	p	5–6	" 1	" 7	" 21	4	i	l c	4–5	7–8	.2
Smeltzer	b	4	April 29	" 3	" 17	5	r o	b c	7–8	8	.2
Sparta	b	3–4	" 29	" 8	" 12	1	i	c	7	9	.2
Stahelin	p	7	May 1	" 3	" 21	7	c co	b c	8–9	7–8	.33
Star	b	6–7	" 2	" 12	" 23	4	c co	s	7	7	.25
Splendid	b	2–3	" 2	" 8	" 21	2	c i	d s	8–9	6–7	.2
Springdale	b	3	" 4	" 12	" 20	3	i	s	7	8	.2
Staples	b	6	" 1	" 3	" 17	3	r c	d c	8	6	.2
Stewart	b	7	April 29	" 2	" 20	2	c i	c	7	9	.2
Stone (Ey)	p	8	May 2	" 2	" 20	7	l c i	d s	6–7	7	.2
Sunnyside	p	6–7	" 6	" 10	" 22	4	i	s	7–8	7	.25
Sunrise	p	4–5	" 3	" 10	" 20	4	c co	s	7	7	.12
Tennessee	b	4	April 29	" 9	" 17	1	l c co	c	7	7	......
Tennyson	b	5	May 1	" 9	" 21	7	r c	l s	7	7	.25
Thompson 40	p	8	" 4	" 12	" 23	6	r c	d s	6–7	7	.12
Thompson 66	p	9–10	" 4	" 12	" 23	6	l c	c	6	8	.12
Timbrell	p	8–9	" 6	" 12	" 24	9	c co	b c	7	7–8	.12
Tonga	p	7	" 3	" 12	" 21	8	r	l s	8	7	.2
Topeka	b	6–7	" 3	" 12	" 20	4	l c	s	5	10	.12
Tubbs	b	8	" 2	" 9	" 21	8	r c i	b c	8	7	.2
Warfield	p	8	" 1	" 2	" 17	10	r c	b c	7	8	.2
Welton	b	......	" 1	" 12	" 17	1	r c	b s	7	8	......
Weston	p	......	" 4	" 12	" 20	2	r	s	7	7	......
Williams	b	8	" 2	" 7	" 20	8	r c i	d s	6	8	.25
Will Warfield	b	8	" 2	" 9	" 22	7	c co	b s	7	7	.25
Wood (Beder)	b	8–9	" 1	" 7	" 20	9	r c	b s	7	7	.2
Woolverton	b	9–10	" 8	" 9	" 23	8	c i	b c	8	9	.33
World Champion	p	7	" 2	" 3	" 20	4	r c	d s	5	7	.25
Wyatt	b	5–6	" 3	" 7	" 20	4	r c	d s	5	7	.25

Bob Bubach.—From W. W. Sewall, Carthage, Mo. Perfect flowered. Plants vigorous, runners abundant, fruit stems short. Fruit large, conical, and slightly compressed; color light crimson; flesh scarlet; texture firm; quality good. This variety resembles Bubach quite closely, both in plant and fruit, but is a little more vigorous in growth.

Carrie Crescent.—From W. W. Sewall. A remarkably vigorous, tall growing plant with broad, dark green leaves. Imperfect flower. Berries large, conical, slightly compressed; color light crimson; seeds large, prominent; flesh scarlet; core open; texture moderately fine; quality good, sprightly. Roots deeply and stands drouth well. If sufficiently productive it may prove of value as a fancy market sort.

Champion.—From David Strouse, Rogersford, Pa. Moderately vigorous, perfect flowering, plant with light green foliage, inclined to rust. Fruit large, long, conical, somewhat compressed, and often deeply furrowed; color dark scarlet; fruit stalks long, prostrate. Poor quality and soft texture make this variety undesirable either for home use or market.

Evans.—From Thompson's Sons, Rio Vista, Va. Perfect flowered. Plants low, spreading, strong. Fruit round conical, medium size; color scarlet; texture moderately firm. Not productive enough for market and of doubtful value as a home berry.

Hattie Warfield.—From W. W. Sewall. Plants tall, strong. Imperfect flower. Berry of medium size; conical compressed; deep scarlet color. Plant vigor, good color and appearance of fruit, and fair degree of productiveness give this variety some promise as a market sort.

Mamie Warfield.—From W. W. Sewall. Imperfect flower. Resembles Warfield in plant growth, but ripened three days later than that variety. Fruit roundish conical;

color light scarlet; seeds small, deeply sunken. Did not hold out well in size this season.

Maybrott.—From E. J. Hull, Olyphant, Pa. Perfect flowered. Plants medium, upright. Fruit round conical; color crimson; flesh bright scarlet; seeds small, sunken. Of good size; quality rather low, acid. Productive and quite vigorous.

No. 7.—From J. Little, Granton, Ont. Perfect flowered. Fruit rather small, long conical; light scarlet color; firm; good quality. Productiveness fair to good.

No. 8.—From J. Little. A very vigorous perfect blooming plant, with dark green foliage, productive of large irregular berries of firm texture and light crimson color. Flesh pink; very good quality.

No. 40.—From J. Little. Imperfect flower. Plants vigorous, foliage light green; fruit stems long, prostrate. Berry irregular; color light scarlet; flesh pink; seeds numerous, reddish, slightly sunken; texture firm. Quite productive, but fruit is sometimes lacking in color.

Omega.—From Thompson's Sons. Plants tall, vigorous. Imperfect flower. Berry large, conical, somewhat irregular; flesh light scarlet; texture a little soft; quality good. Runners abundant, a good plant maker. One of the best late ripening varieties tested this season.

Pet.—From E. J. Hull. Perfect flowered. Somewhat lacking in productiveness. Plants tall, spreading; runners fairly abundant; fruit stalks long, prostrate. Fruit medium size, irregular; crimson color; a little soft; very good quality.

Polly Warfield.—From W. W. Sewall. Imperfect flower. Fruit round, conical; light scarlet color; firm; good quality. Fruit stems upright, holding berries well up from ground. Plants tall, upright, thrifty. Berries did not hold out well in size.

Rob Rusk.—From W. W. Sewall. Perfect flowered. Lacks vigor and productiveness. Plants upright, runners numerous; fruit stalks slender, upright. Berry round conical, compressed; color crimson; flesh scarlet; seeds medium, slightly sunken; texture quite firm; quality rather low.

Sam Sperry.—From W. W. Sewall. Plants low, spreading, perfect. Fruit is of very good appearance; form conical, compressed; color bright scarlet; flesh scarlet; seeds vary from yellow to purple in color; texture very firm. May prove valuable as a medium late home and market berry. Ripened June 12.

Shyster.—From Thompson's Sons. Plants somewhat lacking in vigor, imperfect. The fruit is rather irregular in form and often of poor appearance. Color dark scarlet; flesh bright scarlet; seeds medium, quite deeply sunken; texture firm; quality rather low. Productiveness fair.

Will Warfield.—From W. W. Sewall. Perfect flowered. Ripened a week later than Warfield. Plant strong, upright; runners numerous; fruit stalks medium, upright. Fruit compressed conical; color bright scarlet; flesh light scarlet; seeds yellow, slightly sunken; texture firm. Considered promising as a market variety. Quite productive.

World Champion.—From E. J. Hull. Imperfect flower. Plants medium to tall, slightly spreading. Fruit round conical; color crimson; seeds medium, slightly sunken; flesh scarlet. A berry of good appearance, but acid and quite soft.

RASPBERRIES.

Winter injury to raspberries, except in the case of a few varieties, was slight. Among the black caps, Conrath, Cromwell, Gregg, Mills (15) and Palmer were killed back from one-fourth to one-third, but recovered sufficiently to yield fair crops of fruit. All other black caps, together with the red varieties and purple cane class, escaped uninjured, except for the freezing of the tips. The ordinary spring pruning, or heading in, removed practically all of this injured wood.

Early in spring the plants were sprayed with a solution of one pound of copper sulphate to twenty gallons of water. After growth had started they were again sprayed, this time with Bordeaux mixture. To the Bordeaux was added Paris green, three ounces to forty gallons, to destroy the larvae of the sawfly (Monophadnus rubi), which appeared in considerable numbers and fed on the foliage of the plants. An examination some days later showed the insects, although reduced in numbers, to be still persisting in their work, and another application of Bordeaux mixture and Paris green was made. This proved sufficient to rid the plants of the pest. The sprayings also served to hold the anthracnose well in check. Although it was present

to a slight extent on the old canes of a few varieties, it did not attack the new growth during the season.

Rains occurred at intervals during the fruiting season, and in this, as well as in most other respects, conditions were favorable for a good yield of fruit.

RED VARIETIES.

Of this class, Church, Cuthbert, Loudon and Marlboro were among the most productive. Church, as stated in Bulletin 152 of the sub-station, at first lacked vigor and productiveness here. It has improved in both these characteristics, but the fact that it crumbles badly in picking is quite a strong objection to it.

Loudon, since coming into fruiting, has not failed to be productive, but the plants are not very thrifty growers and the average yields of this variety being proportionate to the growth of the plants would fall considerably short of the yields of some of the stronger growing kinds. However, in nearly all other respects the variety is a good one, and the matter of yield can be helped out by setting the plants closer together than raspberries are commonly set.

Sarah is a new variety, somewhat lacking in vigor and productiveness. The fruit is of good size, roundish oblate, vinous and rather rich, but a little dry. Quality rather low.

BLACK CAPS.

Cumberland, Diamond, Eureka, Farnsworth, Idaho and Kansas were among the more productive of the black varieties.

Cumberland fruited here this season for the first time. The plants are vigorous in growth and very productive. Berries large, firm, juicy, and of a sweet, rich flavor. This variety possesses such a combination of good qualities as seem likely to make it a popular home and market berry.

Diamond is a strong upright grower, productive of medium to large fruit. It is a good market sort.

Eureka ripens over quite a long season and holds out well in size of fruit.

Farnsworth is a very vigorous grower. The fruit is of medium size and quite firm.

Idaho was one of the best late varieties fruited this season. The berries are of large size, very firm, and of attractive appearance.

Kansas, although productive this season, was too small to take well in market.

Livingston was quite productive. The berries are rather small, roundish, slightly oblate, moderately juicy, and of a mild, rich flavor. The plants are strong and vigorous. Requires further trial.

Ransom Everbearing first fruited here this season, and needs further trial. The plants are only moderately vigorous. The berries are small, roundish oblate, mild, rich, of fair quality.

PURPLE CAPS.

Columbian has fruited here three seasons and has not failed during that time to give good results.

Gladstone is vigorous in growth and the fruit is of good quality. However, the berries are apt to run small in size and they crumble badly in picking.

Muskingum fruited heavily this season. The berries are of large size and of quite good quality.

Redfield yielded well, but the berries were rather small.

Otis appears to be identical with Columbian.

RASPBERRY NOVELTIES.

Logan Berry.—This variety was received for trial in 1895, but bore no fruit until this season, although it has been protected each winter and otherwise given good care. The plant is a slow grower of trailing habit. The berries are much larger than the common raspberry, and of a reddish purple color; texture soft; flavor mild, subacid, raspberry like; quality rather low. It does not appear to have any value in this section.

Rubus Xanthocarpus.—Received from the Division of Pomology, Washington, D. C. The plant is a native of Russia. In habit it is low and spreading, like the Strawberry-Raspberry, which it somewhat resembles in growth of plant. It dies to the ground in autumn and comes up from the roots again the following spring. The plants blossomed last spring but set no fruit.

TABULATION OF RASPBERRIES, 1890.

ABBREVIATIONS—c, conical; o, oblate; ob, oblong; r, roundish; b, blackish; p, pubescent; pu, purplish; r, red; y, yellow.

Name.	Species.	Bloom.	First picking.	Last picking.	Product (1-10).	Form.	Color.	Average weight (ounces).	Quality (1-10).
Brandywine	Strigosus	June 8	July 10	July 28	7	r	r	.05	7-8
Cardinal	Neglectus	" 2	" 1	" 28	9	r c	r	.05	6
Carman	Occidentalis	May 27	June 27	" 12	8	r	b	.025	6
Caroline	Neglectus	June 2	July 1	" 28	9	r	y	.037	2
Centennial	Occidentalis	May 29	June 30	" 20	8	r	b	.05	6
Church	Strigosus	June 2	July 5	" 28	8	r	r	.075	7-8
Clark	Occidentalis	May 22	June 27	" 15	8	r	b	.025	5
Columbian	Neglectus	June 5	July 8	" 28	10	r c	p	.062	5
Conrath	Occidentalis	" 1	" 1	" 20	7	r	b	.037	6
Cromwell	Occidentalis	May 25	June 27	" 15	7	r	b	.025	4-5
Cumberland	Occidentalis	" 31	July 5	" 25	10	r	b	.062	7
Cuthbert	Strigosus	June 5	" 6	" 25	8	c	r	.087	5-6
Diamond	Occidentalis	" 1	" 6	" 25	9	r	b	.05	7
Doolittle	Occidentalis	May 27	June 27	" 20	9	r	b	.037	4-5
Early King	Strigosus	" 31	" 27	" 25	7	r o	r	.037	7
Emmet	Neglectus	June 6	July 6	" 28	7	r	r	.075	3-4
Eureka	Occidentalis	May 27	" 1	" 25	10	r o	b	.05	5-6
Farnsworth	Occidentalis	" 30	" 6	" 20	9	r	b	.037	4-5
Gladstone	Neglectus	" 29	" 5	" 22	9	r c	pu	.037	5
Golden Queen	Strigosus	June 6	" 8	" 28	8	r c	y	.025	6-7
Gregg	Occidentalis	May 31	" 6	" 25	9	r	b	.037	8
Green	Occidentalis	" 29	" 27	" 20	9	r o	b	.037	7
Hansell	Strigosus	" 30	June 24	" 20	3	r	r	.037	6
Herstine	Idaeus hyb?	June 2	July 1	Aug. 15	6	r o b	r	.062	9
Hilborn	Occidentalis	May 30	" 6	July 20	9	r	b	.037	5-6
Idaho	Occidentalis	June 2	" 8	" 25	10	r o	b	.05	6
Indiana	Occidentalis	May 27	" 6	" 20	8	r o	b	.05	5
Jap. Wineberry	Phœnicolasius	June 15	Aug. 7	Aug. 30	8	r o	r	......	1
Johnston	Occidentalis	May 31	July 10	July 22	8	r o	b	.037	7
Kansas	Occidentalis	" 29	" 1	" 20	8	r o	b	.05	4
Kenyon	Strigosus	June 5	" 6	" 25	9	r	r	.075	5
Livingston	Occidentalis	May 31	" 6	" 10	8	r o	b	.037	5
Logan	Vit. x Idæus?	" 31	" 10	" 20	6	l c	r	.125	4-5
London	Strigosus	June 2	" 6	" 25	9	r c	r	.075	5
Lovett	Occidentalis	May 27	" 1	" 20	8	r o	b	.037	10
Marlboro	Strigosus x Idæus	" 31	June 30	" 25	8	r c	r	.062	6
Miller	Strigosus	" 31	July 1	" 25	6	r o	r	.037	7-8
Mills 15	Occidentalis	" 31	" 6	" 25	7	r c	b	.037	5-6
Munger	Strigosus	June 2	" 10	" 25	2	r	r	.062	3-4
Muskingum	Neglectus	" 6	" 6	" 22	9	r	pu	.087	4-5
Nemaha	Occidentalis	" 2	" 10	" 22	5	r o	b	.05	5-6
Ohio	Occidentalis	May 27	" 1	" 22	10	r o	b	.025	6
Older	Occidentalis	" 27	June 27	" 20	9	r o	b	.037	5
Otis	Neglectus	June 6	July 10	" 28	10	r	pu	.075	5
Palmer	Occidentalis	May 27	June 27	" 20	9	r	b	.037	7
Phœnix	Strigosus	June 5	July 10	" 28	8	r o	r	.075	6-7
Progress	Occidentalis	May 29	" 6	" 16	9	r	b	.025	5
Redfield	Neglectus	June 6	" 1	" 20	9	r	pu	.037	3
Reeder	Strigosus	" 5	June 30	" 28	7	r o	r	.05	8
Reliance	Strigosus	" 6	July 6	" 28	5	r	r	.037	4-5
Sarah	Strigosus	" 8	" 10	" 28	4	r o	r	.062	4-5
Shaffer	Neglectus	" 5	" 6	" 28	7	r	pu	.062	5-6
Smith Giant	Occidentalis	" 5	" 10	" 25	9	r	b	.062	5-6
Smith Prolific	Occidentalis	May 31	" 6	" 22	6	r o	b	.05	8-9

TABULATION OF RASPBERRIES, 1899.—CONCLUDED.

Name.	Species.	Bloom.	First picking.	Last picking.	Product (1-10).	Form.	Color.	Average weight (ounces).	Quality (1-10).
Sonhegan	Occidentalis	May 27	June 27	July 16	8	r o	b	.037	7
Strawberry-raspberry	Rosæfolius	June 10	July 16	Aug. 10	8	c	r	.2	2
Superlative	Idæus	May 29	" 1	July 25	7	c	r	.037	3-4
Thompson	Strigosus	" 31	June 27	" 20	1	r c	r	.025	4-5
Thwack	Strigosus	June 2	July 6	" 25	8	r	r	.075	6
Turner	Strigosus	" 5	June 30	" 20	8	r c	r	.037	8
Tyler	Occidentalis	May 29	" 27	" 17	8	r	b	.025	6
Winona	Occidentalis	" 27	July 1	" 16	9	r o	b	.025	4-5

BLACKBERRIES.

The canes of a number of varieties of blackberries were quite badly injured by the winter, as were also the roots in some instances. Not only did this injury materially lessen the crop this season, but in the case of the root-injured varieties few new shoots were sent up and there is but little fruiting wood for another year, so the next crop must necessarily be light also.

Childs Tree and Early Harvest were killed to the ground. Agawam, Early King, Maxwell, Thompson, Wilson and Wilson Jr. were badly frozen back, but bore some fruit. Ancient Briton, Eldorado, Lincoln, Nevada, Sanford, Snyder and Taylor were among the varieties least injured. The extent of winter injury in the case of each variety is further indicated in the tabulation.

Among the varieties which gave the most satisfactory results this season were Eldorado, Fruitland, Lawton, Lincoln and Wallace. Eldorado is a spreading, moderate grower, hardy, and very productive. The fruit was inclined to be rather small after the first half of the fruiting season.

Fruitland was among the best of the late sorts. Lawton, although somewhat injured by the winter, made a very good showing. The berries were large and attractive. Lincoln is a large oblong, somewhat irregular shaped berry of good quality. Wallace yielded nearly a full crop and the fruit held out well in size to the end of the season. Snyder and Taylor, although only slightly injured by the winter, yielded but little fruit. Thompson bore fruit of larger size than any other variety, but was so badly winter-killed that the yield was very light.

TABULATION OF BLACKBERRIES, 1899.

ABBREVIATIONS—i, irregular; o, oblong; ov, oval; r, roundish; b, black.

Name.	Bloom.	First picking.	Last picking.	Product (1-10).	Form.	Weight in oz.	Quality (1-10).	Injury by winter.
Agawam	May 29	July 22	Aug. 5	2	o	.15	8	Killed nearly to ground.
Ancient Briton	" 29	" 20	" 10	7	o i	.11	7	Tips killed.
Childs Tree								Killed to ground.
Early Harvest								Killed to ground.
Early King	May 31	July 12	Aug. 1	3	ov i	.15	9	Killed back two-thirds.
Early Mammoth	" 29	" 14	" 5	8	o	17	7	Killed back one-third.
Eldorado	" 27	" 14	" 5	10	o	.12	7-8	Slightly injured.
Erie	June 2	" 20	" 20	7	ov	.13	7	Killed back one-third.
Fruitland	" 5	" 25	" 5	7	r o	.10	8	Killed back one-third.
Kittatinny	" 2	" 20	" 15	7	o	.13	6	Killed back one-half.
Knox	May 31	" 14	" 18	7	o i	.15	7	Killed back one-third.
Lawton	" 29	" 18	" 18	8	o	.12	7	Killed back one-third.
Lincoln	" 29	" 20	" 5	9	ov	.10	7	Tips killed.
Lovett	June 6	" 28	" 5	2	ov i	.07	6	Badly injured.
Maxwell	" 5	" 13	" 20	3	o i	.17	6	Killed nearly to ground.
Minnewaska	" 5	" 18	" 18	3	r o	.17	6	Killed back one-third.
Nevada	" 2	" 20	" 20	5	o	.14	7-8	Slightly injured.
Ohmer	" 19	Aug. 7	" 26	5	r ov	.10	6	Killed back one-third.
Oregon (Everbearing)	" 15	" 18	Sept. 5	10	o	.10	4	Uninjured.
Piasa	May 29	July 18	Aug. 5	6	o i	.12	6	Killed back one-fourth.
Reyner	" 29	" 24	" 5	3	o i	.10	8	Killed back one-fourth.
Sanford	" 27	" 22	" 5	5	r ov	.07	8	Slightly injured.
Snyder	" 27	" 18	" 5	3	r o	.10	7	Tips killed.
Taylor	" 29	" 21	" 12	3	o	.07	8	Tips killed.
Thompson	" 29	" 14	" 5	3	o i	.15	5	Killed nearly to ground.
Triumph (Western)	" 29	" 22	" 5	8	o	.09	7-8	Slightly injured.
Wallace	" 31	" 14	" 15	9	o i	.11	8	Killed back one-third.
Wilson	" 29	" 13	" 5	5	o i	.20	5	Killed back one-half.
Wilson, Jr.	" 29	" 13	" 5	4	o i	.17	5	Killed back one-half.

CURRANTS.

Most varieties of currants fruited well this season, but in the case of a few sorts the yield was light, owing to imperfect setting of the fruit, the bunches being quite loose.

The treatment given the plants differed but little from that of former seasons. In early spring they were sprayed with a solution of copper sulphate, and later when growth had started an application of Bordeaux mixture and Paris green was made to prevent the attack of fungi and to destroy the worms which were just beginning to make their appearance.

NOTES ON VARIETIES.

Cherry made a good growth and produced a fair amount of fruit. The clusters were large and well filled. Fay, which resembles the Cherry closely in plant and fruit, gave results quite similar to that variety. Holland bore a good many loose imperfect clusters and the berries were quite small. The plants were attacked by aphides in early summer and were sprayed with kerosene emulsion to destroy the pest. This variety is quite subject to the attack of plant lice.

Lancaster is a new variety which bore its first fruit here this season. The clusters were compact, but rather small. Berries medium in size, of good quality. Requires further trial.

London, which has received favorable mention in former reports, again gave good results. From the standpoint of a market variety, this is one of the best in the substation collection.

Pomona failed to make a very good showing because of the number of imperfect clusters borne. However, size and quality of the fruit are in its favor. It is a new variety and requires further trial. Red Dutch lacked productiveness. The plants are very strong growers, and the fruit, which is of good quality, is borne in rather compact, medium sized clusters. White Dutch, recognized as one of the best of the white varieties, bore a full crop. Wilder was one of the most productive of the large-fruited kinds. The plants are quite tall and vigorous. The fruit is borne in long, compact clusters. Quality very good.

TABULATION OF CURRANTS, 1899.

KEY.—Form—r, roundish. Color—b, black; r, red; w, white. Use—d, dessert; k, kitchen; m, market.

Name.	Origin.	Planted.	Bloom.	Ripe.	Productiveness (1–10).	Form.	Color.	Quality.	Vigor.	Weight in oz.	Use.
Champion	England	1899	May 2	July 14	5	r	b	6	8	.11	k m
Cherry	Europe	1888	Apr. 27	" 6	7	r	r	5	7	.21	m
English	England	1892	May 2	" 14	8	r	b	4	10	.13	k m
Fay	New York	1882	Apr. 27	" 6	6	r	r	6	5	.28	k m
Holland	Europe	1889	" 29	" 11	8	r	r	4	7	.14	k m
Lakewood	Ohio	1890	" 28	" 11	10	r	r	5	8	.24	k m
Lancaster		1898	" 30	" 12	4	r	w	8	7	.15	k d
Lee	America	1888	May 3	" 14	5	r	b	3–4	5	.12	k m
London	England	1890	Apr. 29	" 6	9	r	r	4–5	10	.20	k m
North Star	Minnesota	1890	" 28	" 11	5	r	r	7–8	10	.14	k m
Pomona	Indiana	1897	" 28	" 11	5	r	r	6–7	5	.20	k m
Red Dutch	Europe	1888	" 27	" 11	5	r	r	7–8	10	.20	k m
Ruby Castle	Europe	1892	" 28	" 11	9	r	r	5	9	.17	k m
Ruby, Moore	New York	1890	" 28	" 6	9	r	r	8	6	.27	k m
Saunders	Ontario	1890	May 2	" 14	9	r	b	3–4	8	.10	k m
Select, Moore	Massachusetts	1890	Apr. 27	" 6	5	r	r	5	7	.26	k m
Versaillaise	France	1888	" 27	" 6	10	r	r	6	8	.16	k m
Victoria	England	1888	" 29	" 11	7	r	r	5–6	9	.19	k m
Wales, Prince of	Ontario	1890	May 1	" 14	5	r	b	5–6	10	.12	k m
White Dutch	Europe	1888	Apr. 28	" 11	5	r	w	10	9	.16	k d
White Gondoin	Europe	1890	" 29	" 1	10	r	w	9	7	.24	k d
White Grape	Europe	1888	" 28	" 11	8	r	w	8	9	.21	k m d
Wilder	New York	1890	" 28	" 11	9	r	r	6	10	.29	k m

GOOSEBERRIES.

Soon after the leaves had opened on the gooseberries in the spring, the plants were sprayed with Bordeaux mixture and Paris green, and about two weeks later a second application was made.

These early sprayings were followed by applications of potassium sulphide, three ounces to ten gallons of water, for the purpose of holding the mildew in check. The first application was made June 1, and from that time until after the fruit had been picked applications were made at intervals of about ten days. Although the disease made its appearance on several English varieties, the spray prevented any serious injury either to plants or fruit.

All the English varieties except Orange and Champion bore good crops. Keepsake gave better results than any other variety, taking yield and size of fruit into consideration. Some single specimens weighed half an ounce. Lancashire made nearly as good a showing, and Auburn, Chautauqua, Columbus and Triumph were fully as productive, if not quite so good in other respects.

A number of the American kinds were quite unproductive, as was the case last year. Houghton yielded almost no fruit, while Downing produced only about half a crop. Pearl was the most productive variety, but the yield did not amount to a full crop. Red Jacket and Smith stood next in productiveness.

All fruit not needed for experimental purposes was marketed this season, as has been the custom in former years. The English gooseberries sold in Chicago at from \$1.25 to \$1.50 per sixteen quart case, which was about double the price received for American berries shipped at the same time. This difference in prices usually exists and will well repay the extra labor of spraying the English varieties to prevent mildew. There is little doubt but that they can be raised with profit if given the right kind of care. Next spring it is proposed to set out a new plantation of one hundred plants each of about half a dozen of the better English kinds in order to test them more thoroughly from a commercial standpoint.

TABULATION OF GOOSEBERRIES, 1899.

KEY.—Form—l, long; o, oval; r, round. Color—g, green; r, red; w, white; y, yellow.

Name.	Species.	Planted.	Bloomed.	Ripened.	Form.	Color.	Weight in oz.	Productiveness (1-10).	Quality (1-10).	Vigor (1-10).
Apex	Grossularia	1893	April 28	July 11	o	y g	.21	10	8-9	7-8
Auburn	Grossularia	1890	" 28	" 11	o	y r	.27	10	8-9	8-9
Bendelon	Grossularia	1894	" 29	" 11	o	y g	.21	10	5	5
Champion	Grossularia	1891	" 29	" 11	r o	y g	.14	7	6	10
Chautauqua	Grossularia	1892	" 28	" 6	r o	y g	.27	10	8-9	7-8
Columbus	Grossularia	1894	" 28	" 6	r o	y g	.31	10	10	7-8
Downing	Oxyacanthoides	1888	" 28	" 11	r o	w g	.13	5	7	10
Golden (Prolific)	Grossularia	1891	" 28	" 11	o	y	.20	9	6-7	8
Houghton	Oxyacanthoides	1888	" 29	" 11	r o	r	.07	1	10	10
Industry	Grossularia	1889	" 28	" 11	r o	r	.29	10	6-7	5
Keepsake	Grossularia	1894	" 28	" 6	o	g w	.31	10	8-9	5-6
Lancashire	Grossularia	1894	" 28	" 11	r o	r	.29	10	7-8	8
Orange	Grossularia	1890	" 28	" 11	r o	y	.06	1	10	10
Pale Red	Oxyacanthoides	1890	" 29	" 11	r o	r	.07	3	9	10
Pearl	Oxyacanthoides	1890	" 28	" 11	r o	g	.12	8	9	7-8
Red Jacket	Oxyacanthoides	1890	" 29	" 11	r o	r g	.17	7	7-8	8
Smith	Oxyacanthoides	1888	" 28	" 11	o	g	.12	6	8-9	2
Strubler	Cynosbati	1892	" 28	" 11	r o	g y	.10	5	7-8	3
Tree	Cynosbati	1892	May 1	" 10	r o	r	.10	2	5-6	10
Triumph	Grossularia	1890	April 28	" 6	r o	g y	.26	10	7-8	7-8

CHERRIES.

All varieties of cherries came through the winter without the slightest injury and the crop this season at the sub-station was larger than ever before.

Cherries, in common with other fruits, have been given clean culture since they were first planted, with the exception of a small block of sixty trees. This block, which is made up of thirty-three sweet and sour varieties, was seeded down two years ago for the purpose of checking too rapid growth of the trees and thus preventing bark burst, to which the sweet kinds especially are liable. The growth of the trees has been checked, but the orchard will be left unplowed for at least another year, for further comparison with trees under cultivation. This fall the trees in sod were given an application of wood ashes and ground bone, while the cultivated trees will receive no fertilizer beyond what may arise from the turning under of what promises to be a fair stand of crimson clover.

Early in the spring the trees were sprayed with a solution of one pound of copper sulphate to fifteen gallons of water. When the fruit had set, an application of Bordeaux mixture and Paris green was made. About the middle of summer the sweet cherries were again sprayed with Bordeaux mixture, with the idea of preventing premature falling of the leaves, due to the attack of shot hole fungus. This apparently had the desired effect, for, although the disease had appeared to a slight extent on a few trees before they were given this summer spraying, it did not become prevalent, and the foliage for the most part held on well until autumn.

MORELLOS.

Baendor is a new variety which first fruited here this season. The tree is moderately vigorous with a round, spreading head. The fruit is roundish heart-shaped; medium size; dark red in skin and flesh; of good quality. Has been rather slow in coming into bearing and the crop this season was light.

Bessarabian, Dyehouse, Frauendorfer, Lithauer, Montmorency, Northwest, Ostheim, Ostheimer, Richmond, Sklanka, Spate Morello and Suda, bore very full crops. A number of them are Russian varieties, most of which have heretofore been quite unproductive.

Among the twenty-seven varieties of sour cherries now on trial, Montmorency still maintains its standing as one of the most valuable home and market sorts. Brusseler Braune, a late ripening Russian variety, is coming into favor because of size and beauty of fruit and vigor of tree. It lacked somewhat in productiveness this season.

DUKES.

Galopin is a new Duke variety, trees of which were received in 1891. The fruit is roundish oblate; stalk stout, one and one-half inches long, set in a medium cavity; color light red; flavor sub-acid, pleasant; flesh tender and of good quality. Tree vigorous, with spreading head.

Rupp is an upright, spreading, vigorous grower. Fruit roundish, elongated, suture marked by a line; stalk one and three-fourths inches long, moderately stout, set in a broad, deep, somewhat irregular cavity; color light yellow, mottled and marbled with dull red; flavor sub-acid, rich; flesh light colored, moderately firm; quality very good. This is a new variety received for trial in 1894.

Several of the Duke varieties were rather unproductive this season, but the following gave satisfactory yields: Carnation, Hortense, Magnifique, Montrueil and Olivet.

Carnation is a large dark red cherry of very good quality. Although it was one of the most productive kinds last year, it again bore a full crop this season. Hortense and Olivet did not bear so much fruit as the other varieties mentioned, but the yield was considerably larger than in former years. Montrueil has not only proven an early and productive variety, but the fruit is of large size, attractive appearance and good quality. A valuable variety for home use or market.

HEARTS AND BIGARREAUS.

Badacsony, Baltavar, and Mednyansky are Hungarian varieties, scions of which were received in 1894. They gave good results this season and are considered prom-

ising. All are firm fleshed varieties of good quality. The two first mentioned were described in the report of last year, while the third is given more extended mention below. It will be observed upon comparison with last year's report that a slight change has been made in the spelling of the names of the varieties, which is in accordance with a revision made since the scions were received.

La Maurie is a new early variety which this season ripened only two days later than Early Purple. Tree upright, slightly spreading, moderately vigorous. Fruit obtuse, heart-shaped, slightly compressed, suture obscure; stalk slender, one and one-half inches long, set in a shallow cavity; color dark purple, almost black when fully ripe; flavor sweet, mild; texture tender, juicy; quality fairly good. Requires further trial, but will need to improve very much in size to be counted of value.

Mednyansky.—Tree upright, spreading, quite vigorous; with large drooping leaves. Fruit heart-shaped, suture variable, in some specimens indistinct, in others marked by a well defined ridge from cavity to apex; stalk stout, one and one-fourth inches long, set in a narrow, deep, irregular cavity; color very dark purple turning to black in exposed and fully matured specimens; flavor sweet, sprightly, rich; texture very firm; quality very good. Inclined to be a little bitter before fully ripe. The fruit was not quite uniform in size, some specimens being large, while others were below medium in size. Aside from this, the variety made an excellent showing this season.

Purity.—Tree upright, spreading, fairly vigorous. Ripe June 24. Fruit heart-shaped, compressed; suture broad, half around, rather indistinct; stalk one and one-half inches long, slender, set in a broad shallow cavity; color amber, shaded and marbled with bright red; skin thin, showing netted texture of flesh; flavor rich, sweet; texture tender, juicy, melting; quality very good. Rather tender for a market fruit, but further trial may show it to be of value for home use.

Schmidt.—Tree upright, spreading, very vigorous. Fruit obtuse heart-shaped, slightly compressed; stalk stout, one and one-half inches long, set in a broad deep cavity; color dull red, mottled and marbled with carmine; flavor vinous, sweet; texture very firm; quality good. A very handsome fruit, and likely to prove of value if productive.

Ulatis (California Advance).—Tree very vigorous with round, spreading head. Fruit heart-shaped, slightly compressed, suture somewhat obscure; stalk stout, one and one-half inches long, set in a round rather deep cavity; color dark, rich, glossy, purple; flavor sweet, vinous; flesh purple, tender, juicy; quality very good. A cherry of large size and attractive appearance.

Cleveland, Coe, Eagle, Elton, Ida, Mary Kirtland, Napoleon, Rockport, Spanish, Tartarian, Windsor and Gov. Wood deserve mention as among the more productive kinds. Ida is a new variety which received favorable mention in the report of last year. Not only was the crop this season a large one, but in other respects the variety again showed itself to be of value. Windsor is also a comparatively new variety which has rapidly grown in favor. The crop this year in no wise detracted from the opinion of its worth expressed in the last two reports of the sub-station.

TABULATION OF CHERRIES, 1899.

Name.	Species.	Planted.	Bloomed.	Ripened.	Weight of berry in ounces.	Productiveness.—Scale 1-10.	Quality.—Scale 1-10.	Vigor.—Scale 1-10.
Angouleme	Duke	1888	Apr. 29	July 12	.17	2	8	10
Badacsony	Avium	1894	" 28	June 29	.20	6	8	9
Baendor	Morello	1892	May 1	July 1	.12	1	6-7	6-7
Baltavar	Avium	1894	Apr. 28	June 28	.22	5	8-9	9-10
Bessarabian	Morello	1888	" 29	July 3	.11	10	5	10
Brusseler Braune	Morello	1888	May 1	" 13	.15	6	7-8	10
Carnation	Duke	1891	Apr. 29	June 30	.15	9	7-8	10
Centennial	Avium	1893	" 28	" 19	.20	3	7	6
Choisy	Duke	1888	" 29	" 24	.12	1	10	6
Cleveland	Avium	1888	" 29	" 18	.16	8	7-8	8
Coe	Avium	1888	" 28	" 19	.15	10	10	9
Downer	Avium	1888	" 29	July 3	.14	7	10	7
Dyehouse	Morello	1891	" 30	June 20	.11	10	5	10
Eagle (Black)	Avium	1888	" 29	" 26	.15	8	10	9-10
Early Purple	Avium	1892	" 28	" 8	.15	6	8	8
Elton	Avium	1892	" 29	" 17	.17	7	8-9	7-8
Esperon	Morello	1892	" 29	" 28	.16	6	5-6	10
Eugenie	Duke	1888	" 29	" 23	.14	5	8	9
Everbearing	Duke	1892	" 29	July 1	.14	4	6	7
Florence	Avium	1892	" 29	June 26	.09	6	6	9
Frauendorfer	Morello	1888	" 29	" 30	.11	10	6-7	10
Galopin	Duke	1891	" 29	July 3	.16	1	7	8
George Glass	Morello	1888	" 30	June 30	.16	8	8	10
German	Avium	1896	" 28	" 28	.15	10	5	10
Griotte du Nord	Morello	1888	May 1	July 12	.14	5	5	10
Hortense	Duke	1888	Apr. 29	June 24	.17	7	9	8
Ida	Avium	1893	" 28	" 15	.20	10	8	9
King Morello	Morello	1891	" 29	" 28	.14	8	7	9
Knight Early	Avium	1891	" 29	" 26	.16	1	9	9
La Maurie	Avium	1893	" 28	" 10	.11	5	6	7
Lancaster	Morello	1894	" 29	" 26	.10	6	6	10
Late Duke	Duke	1890	" 30	" 30	.18	3	7	7
Lithauer	Morello	1892	May 1	July 12	.07	10	4-5	10
Magnifique	Duke	1888	" 1	" 18	.17	10	7	9
Mary Kirtland	Avium	1891	Apr. 29	June 17	.19	10	9	8
May Duke	Duke	1888	" 29	" 24	.12	1	8	8-9
Mednyansky	Avium	1894	" 28	" 29	.21	6	8-9	10
Mezel	Avium	1891	" 28	" 23	.17	8	9	9
Minnesota (Ostheim)	Morello	1892	May 1	July 1	.11	8	6	9-10
Monarch	Morello	1898	" 1	June 26	.07	......	6-7	......
Montmorency	Morello	1888	Apr. 29	" 30	.12	10	6	8
Montrueil	Duke	1890	" 29	July 1	.15	8	8-9	9-10
Napoleon	Avium	1892	" 28	June 30	.24	10	6	9
Northwest	Morello	1893	May 1	July 3	.10	10	4	8
Ohio (Beauty)	Avium	1891	Apr. 29	June 17	.17	1	6-7	9
Olivet	Duke	1891	" 29	" 26	.14	7	7	9
Orel 25	Morello	1893	" 30	July 12	.15	1	8	10
Orel 27	Morello	1893	" 30	" 20	.19	2	5	10
Ostheim	Morello	1888	" 29	June 29	.07	10	4	9
Ostheimer ?	Morello	1893	" 29	" 30	.10	10	3-4	10
Philippe Louis	Morello	1888	" 29	" 26	.11	8	8	9
Plymouth Rock	Avium	1896	" 29	" 29	17	1	8	9
Purity	Avium	1893	" 29	" 21	13	1	9	7
Richmond	Morello	1893	" 29	" 24	.11	10	5	10
Rockport	Avium	1891	" 29	" 17	.16	10	8	8-9

TABULATION OF CHERRIES, 1899.—CONCLUDED.

Name.	Species.	Planted.	Bloomed.	Ripened.	Weight of berry in ounces.	Productiveness.—Scale 1-10.	Quality.—Scale 1-10.	Vigor.—Scale 1-10.
Royal Duke	Duke	1891	May 1	June 26	.14	3	7-8	7
Rupp	Duke	1894	Apr. 29	" 26	.17	1	9	8-9
Schmidt	Avium	1894	" 29	" 29	.22	1	7	10
Sklanka	Morello	1888	" 29	" 23	.11	10	5	10
Spanish (Yellow)	Avium	1891	" 29	" 28	.22	9	10	9
Spate Morello	Morello	1888	May 1	July 1	.11	10	5-6	7
Strauss	Morello	1888	Apr. 29	June 28	.11	5	5-6	10
Suda	Morello	1893	May 1	July 12	.12	10	3-4	10
Tartarian (Black)	Avium	1888	Apr. 28	June 20	.17	9	10	9
Ulatis (Cal. Adv.)	Avium	1893	" 28	" 12	.15	3	8	10
Weir 2	Morello	1893	" 29	" 26	.15	10	7	8
Windsor	Avium	1891	" 28	July 3	.20	10	7	9
Wood (Gov.)	Avium	1891	" 29	June 15	.17	10	8	9
Wragg	Morello	1892	May 1	July 12	.12	8-9	4-5	8-9

PEACHES.

Although most kinds of fruit at the sub-station stood the severe test of last winter remarkably well, the damage to peaches was considerable. Out of 225 varieties on trial, 40 were lost as a result of the freeze. With but few exceptions the wood of surviving varieties was more or less discolored and many (in the case of some varieties all) of the fruit buds were killed. However, 47 varieties proved sufficiently hardy to mature some fruit, and these kinds have been incorporated in the tabulation given.

It is but fair to say that the extent of the injury at the station should not be taken as an indication of the damage sustained by peaches generally throughout the section. In most of the orchards about South Haven, but few if any trees were killed, and in many instances fair crops of fruit were harvested. This difference in favor of the commercial orchards may doubtless be attributed largely to their greater elevation, the station grounds being located immediately on the lake shore, at an altitude considerably less than that of most of the neighboring country. But the fact that the station orchards contained such a large number of varieties should also be taken into consideration. Among so many kinds quite a proportion naturally proved much less hardy than many of the well tested commercial varieties largely planted throughout this section.

With the exception of a few varieties which showed but little discoloration in wood, and a number included in a pruning experiment mentioned later, the trees were cut back to wood from one-half to three-quarters of an inch in diameter. This severe pruning was for the purpose of removing injured wood, lowering the tops in the case of some of the older trees, and stimulating a more vigorous growth, thus aiding in the repair of winter injuries. The trees were apparently benefited by this treatment. They made a good growth, yet ripened their wood well, and this fall are in good condition for winter.

Among the varieties which made the best showing this season were Alexander, Brunson, Brown, Gold Drop, Lewis, Longhurst and Willett. Brown is an early white fleshed peach resembling Lewis. It is fully as hardy as that popular variety and this season was more productive. Longhurst is a new variety which ripened in late September. It is a large yellow peach of the Chili type and proved one of the best varieties which fruited this season. Willett is a yellow freestone of good size and good quality. Ripened September 25.

EXPERIMENT IN PRUNING.

The question of when and how much to prune frost injured trees was one frequently asked by fruit growers after the freeze. In order to study the effect of pruning at different times and to varying degrees, and to gain, if possible, some new light on the subject, an experiment was undertaken. Eight rows of twelve trees each were chosen for the test in a block of ten-year-old trees. These rows included forty-eight varieties, most of which were considerably injured. The pruning was done at intervals of ten days, between April 1 and May 1, two rows being pruned at a time. The manner of pruning was the same in the case of each lot of trees pruned. The first two trees in each row were cut back on wood from one and one-half to two inches in diameter; the next two were pruned a little less severely, and so on, gradually lessening the amount of wood removed until the last four trees in the row were reached. These four were pruned in the ordinary way by thinning out and heading in a part of the growth of the year before. On May 1, when the last pruning was done, trees on which the fruit buds had not been entirely destroyed were in blossom and the leaf buds were beginning to open.

As the growing season advanced no variation could be discerned that could be ascribed to difference in time of pruning. But there was an appreciable contrast between trees pruned to different degrees. Among those cut back on wood from one to two inches in diameter, twenty-one, or about one-third of the whole number thus severely pruned, either failed to start or sent out but a few weak shoots, which soon withered and died. Of the trees pruned in the ordinary way none were lost, although a few died back to a slight extent. They started a little earlier in the spring than did the trees severely pruned, and during the season made very fair growth. Most of the severely pruned trees which survived, although belated in starting, sent out strong and vigorous new shoots. On a part of these trees the new growth was well distributed and symmetrical new tops were formed, while in the case of others only a few scattered shoots sprang from stumps of the large branches left in pruning. Trees headed in on wood from about half or three-quarters of an inch in diameter, as were a part of those included in the experiment, and nearly all others on the grounds, with but few exceptions, survived and made a good development of new wood.

To summarize briefly, difference in time of pruning made no appreciable difference in results. Very severe pruning or removing all the tops down to the stumps of main branches proved dangerous to the life of the trees. More moderate pruning or cutting back on branches from one-half to three-fourths of an inch in diameter gave good results. Trees pruned in the ordinary way were not, at the close of the season, in quite so good condition as those pruned more severely. These results are not considered conclusive. Further differences in the behavior of trees differently treated may yet be detected, as the observations have extended only over one season.

EXPERIMENTS IN SPRAYING.

For the purpose of further testing the best methods of combatting leaf curl, which is one of the most serious fungus diseases of the peach in Michigan, experiments with Bordeaux mixture and copper sulphate solution were undertaken. About the middle of March, part of the trees included in the experiment were sprayed with copper sulphate, one pound to twenty gallons of water. On April 20, at which time the buds were beginning to show some color, but before any had actually opened, other trees, nearly all of the same varieties as those sprayed in March, were given an application of the same solution used at the same strength. At the same time some of the trees first sprayed were given a second application. After the fruit had set, a row of trees sprayed early and another sprayed late were again sprayed. For this application, Bordeaux mixture, consisting of four pounds copper sulphate, four pounds of lime and forty gallons of water, was used.

The season proving unfavorable for leaf curl, but few varieties were badly affected, no matter what the treatment had been. However, the disease appeared sufficiently to show a marked difference between early and late sprayed trees. Trees sprayed in April just before the opening of the buds showed a much larger per cent of curled leaves than those sprayed in March. The second application of copper sulphate to early sprayed trees made no appreciable difference in the amount of curl, and the same was true of Bordeaux mixture applied after the fruit had set. These results accord very nearly with those obtained by somewhat similar experiments carried on here each spring for a number of years past. In a general way it may be said that thorough spraying with copper sulphate solution in March, while the buds are dormant, is, under most conditions, an effectual remedy for curl leaf.

TABULATION OF PEACHES, 1899.

ABBREVIATIONS.—Form—c, compressed; o, oblate; ov, oval; r, round. Color—c, creamy; g, green; r, red; w, white; y, yellow. Adhesion—c, cling; f, free; s, semi-cling. Quality—1 to 10—1, very poor; 10, best. Flowers—l, large; s, small. Glands—g, globose; r, reniform; s, serrate.

Name.	Planted.	Bloomed.		Glands.	Ripened.	Adhesion.	Weight of specimen in ounces.	Productiveness—Scale 1-10.	Form.	Color.		Quality—Scale 1-10.
		Date.	Size.							Skin.	Flesh.	
Albright	1890	May 1	s	g	Oct. 9	f	4.25	1	r	c w	c w r	5-6
Alexander	1892	" 1	l	g	July 27	c	4.9	4	r c	r	g w	4-5
Barber	1893	" 1	l	r	Sept. 25	f	3.6	1	r ov	y r	y	7
Bishop	1890	" 1	s	g	Aug. 26	f	5.1	1	r	c w r	w	8
Boyle	1890	" 2	s	g	Sept. 8	f	5.55	1	r ov	y r	y	7
Brunson	1894	" 1	s	r	Sept. 19	f	3.3	4	r ov	y	y	6
Brown	1892	Apr. 30	l	r	Aug. 21	f	5.85	7	r	y r	w	5-6
Canada	1892	May 1	l	g	" 26	s	5	1	r	g r	w	4-5
Champion (Ohio)	1894	" 1	s	g	Sept. 1	f	8.8	2	r	c w r	w	9-10
Champion (Michigan)	1890	" 1	l	r	Aug. 25	c	3.35	1	r c	g w r	w	5
Corner	1890	" 1	s	r	Sept. 20	f	4	1	r ov	y r	y	6
Crosby	1892	" 1	s	r	" 19	f	4.5	3	r	y r	y	7
Crothers	1890	" 1	s	g	" 28	f	5	1	r ov	w r	w	6-7
Early Michigan 15	1894	" 2	l	g	" 2	f	4.85	1	r	c w r	c w r	6
Early Michigan 16	1894	" 1	l	r	" 5	f	6.2	1	r	c w r	w r	9-10
Engle (Mammoth)	1892	" 1	s	g	" 8	f	6.18	1	r	y r	y r	9-10
Ford 1	1894	" 1	l	r	Aug. 24	s	5.85	1	r	c w r	c w r	6
Gold Drop	1890	" 1	l	r	Oct. 6	f	3.2	4	r ov	y r	y	7-8
Haas	1890	" 1	l	r	Aug. 17	f	5	2	r	w r	w	6
Infant Wonder	1892	" 1	s	g	Sept. 8	f	4.95	1	r ov	w r	c w r	3
June Rose	1894	" 1	l	g	" 8	f	4.25	1	r ov	w r	w r	7
Kallola	1892	" 1	l	r	" 25	f	5	1	r ov	c w	w r	3-4
Lemon Free	1894	" 1	l	r	Oct. 9	f	4.9	1	r ov	g y	y	4
Lewis	1890	" 1	l	r	Aug. 22	f	5.2	5	r c	c w r	c w r	6-7
Longhurst	1894	" 1	l	g	Sept. 25	f	5	8	ov	y r	y r	7
Magdala	1890	" 1	s	r	" 2	f	4.9	4	r	c w r	c w r	8-9
Marshall	1890	" 1	s	r	Oct. 9	f	3.8	1	r ov	y r	y r	5-6
Oriole	1894	" 1	l	r	Sept. 25	c	5.5	1	ov	y	y r	4-5
Pallas	1894	" 1	l	g	" 8	f	5.5	4	r ov	w r	c w r	6-7
Pickett	1890	" 1	s	r	Oct. 9	c	3	1	ro	y r	y	5-6
Red Seedling	1893	" 1	l	g	Aug. 26	s	4.8	1	r	w r	w	6
Reed	1890	" 2	s	g	Sept. 8	f	5.25	1	r ov	y r	y	7-8
River Bank	1892	" 2	l	g	July 26	s	5	1	r	g r	g w	5
Rivers	1888	" 1	l	r	Aug. 10	f	6.75	1	r c	c w r	c w	6-8
Salway	1890	" 1	s	r	Oct. 9	f	4.3	2	r	y r	y r	6-7
Scott	1890	" 1	s	g	" 5	f	2.8	2	r ov	y r	y	7
Snow Late	1890	" 1	s	r	Sept. 8	f	3.5	1	r ov	y r	y	7
Southern Early	1890	" 1	s	r	" 8	f	4.5	1	r	y r	y r	7-8
Spottswood	1894	" 3	l	r	" 25	f	4.5	1	r ov	w	w r	6-7
Stevens Late	1890	" 1	s	r	" 8	f	3.9	1	r	c w r	w r	5-6
Strong (Mammoth)	1892	" 1	s	g	" 25	f	4	1	r	c w r	w r	5-6
Summer Snow	1894	" 1	l	g	Oct. 2	c	2.5	10	r	c w	c w	4
Toquin	1892	" 2	l	r	Sept. 20	f	3	1	r	y r	y r	7
Triumph	1896	" 1	l	g	Aug. 9	s	3	1	r	y r	y	7-8
Troth	1890	" 1	s	g	" 27	f	3.85	2	r	c w r	w r	8
Willett	1894	" 1	l	r	Sept. 25	f	4	7	r c	y r	y r	6
Worthen	1890	" 1	s	r	" 8	f	6.6	1	r ov	y r	y r	8

PEARS.

Late in March, pear trees, with the exception of a few rows, were sprayed with copper sulphate, one pound to fifteen gallons of water. On May I the trees omitted in the first spraying were given an application of Bordeaux mixture. The object of this variation in treatment was to test the relative value of spraying with copper sulphate solution while the buds are dormant and spraying with Bordeaux mixture just as the buds are about to open. No difference could be detected in favor of either line of treatment during the season. After the fruit had set the trees were again sprayed, Bordeaux mixture and Paris green being used. Neither insects nor fungi proved troublesome during the season. Nearly all varieties of bearing age yielded some fruit, and in the case of quite a number of kinds the yield amounted to a good crop.

On August 4, and again two weeks later, one tree each of Bartlett and Clapps Favorite was sprayed with liver of sulphur (one ounce to four gallons of water), to see if the color of the fruit could be heightened by the use of this solution. Trees of the same varieties were left untreated to serve as checks. Some of the fruit was also dipped in the solution at intervals of two or three days for about three weeks. When the fruit had ripened, that of sprayed trees and specimens dipped were compared with fruit untreated. No difference in color which could be attributed to the use of liver of sulphur was detected.

The following varieties fruited here this season for the first time:

Bartlett Seckel.—Fruit small to medium, oblong pyriform; cavity none; stalk one inch long, slender; basin shallow, slightly corrugated; calyx open, lobes erect; color light yellow with handsome red cheek; flesh white, melting, slightly granular; quality very good; season first to middle of October. The tree is an upright, vigorous grower, with stout, reddish brown shoots.

Hardy.—Medium size, obovate, with a slight cavity and a stalk about one inch long; basin shallow, regular; calyx open, lobes upright; reflexed at tips; calyx tube cup-shaped; flesh white, juicy, buttery, melting, fine grained; season late September and early October; quality very good. The trees which have been planted eleven years are upright and vigorous in growth.

Longworth.—Trees upright, vigorous, with dull yellowish shoots. Fruit medium, obovate turbinate; stalk one inch long, moderately stout; basin broad, shallow; calyx open or partly open; color light waxen yellow, sprinkled with small russet dots; flesh white, lacking in juice, firm, breaking coarse and granular; flavor sweet; highly perfumed; quality poor; season middle of September. Does not appear to be of value here.

Superfin.—An old French variety valued as a dessert sort. Fruit large, roundish, inclined to pyriform; stalk one and one-half inches long, curved; calyx open, segments recurved; cavity none; basin deep, rather abrupt; color greenish yellow, slightly russeted and thickly dotted with small gray dots; flesh white, very juicy, melting, fine grained; quality very good; season October. Tree upright, with a compact head; young wood yellowish brown with prominent buds.

Wilder.—Tree upright, vigorous, rather a tardy bearer here. Fruit medium to large, obtuse pyriform to obovate, stalk one inch long, rather stout, set in a narrow, russeted cavity; basin broad plaited; calyx closed, lobes enlarged and fleshy at base; color greenish yellow with light red cheek in exposed specimens; flesh white, tender, half fine, rather dry; quality rather low, season middle of August. If productive, this variety may have some value as an early market sort on account of size and good appearance.

TABULATION OF PEARS, 1899.

ABBREVIATIONS.—Season, months—b, beginning; e, end; m, middle. Form—e, elongated; i, irregular; o, oblate; ob, oblong; obo, obovate; obt, obtuse; ov, ovate; p, pyriform; r, round; t, turbinate. Color—b, brown; c, crimson; g, greenish; r, red; ru, russet; w, whitish; y, yellow. Texture—b, buttery; f, firm; g, granular; m, melting; t, tender; br, breaking. Flavor—a, acid; m, mild; as, astringent; j, juicy; s, sweet; v, vinous; p, perfumed. Use—d, dessert; k, kitchen; m, market.

Name.	Planted.	Bloomed.	Season.	Vigor.—Scale 1-10.	Origin.	Product.—Scale 1-10.	Weight in ounces.	Form.	Color. Skin.	Color. Flesh.	Texture.	Flavor.	Quality.—Scale 1-10.	Use.
Angouleme	1891	April 29	Oct., Nov	10	France	10	10	ob obo	g y ru	w	b	m v	6-7	m
Anjou	1888	May 1	Oct., Nov	8	France	1	6.45	obt p	g y r	w	m	v p	8-9	d m
Ansault	1889	" 1	Sept. e Oct	8	France	2	3.8	obo obt p	y ru	w	t b m	p	6	m
Barry (P.)	1892	" 1	Dec., April	8	California	2	6.35	e p obt	y ru	w	f	s v	3-4	d m
Bartlett	1891	" 1	m Sept	8	England	8	10	ob obt p	y ru	w	t b	v p	6	d m
Bartlett Seckel	1894	" 1	m Oct	9	....	1	3.25	ob p	y r	w	m	s v	8	d
Bloodgood	1888	" 1	m Aug	10	New York	7	2.3	t obo	y ru	y w	b m	s p	6	d m
Bosc	1888	" 1	Oct	10	Belgium	3	7	p	y ru	w	b m	p j	10	d m
Boussock	1891	" 1	Sept., Oct	10	Belgium	1	7.45	r obo	y ru	w	b m	s j p	7	m
Buffum	1891	" 1	Oct., Nov	10	Rhode Island	1	3.1	ob obo	y r ru	w	t b g	m	6	m
Clapp Favorite	1888	" 1	m Aug	10	Massachusetts	10	9	t	y b ru	w	b m	v	6-7	d m
Comice	1891	" 1	m e Oct	10	France	10	7	r obt p	g b r	w	b m	j s p	9	d m
Dana Hovey	1888	" 1	Oct., Nov	10	Massachusetts	4	3.9	obo obt p	y ru	y w	g m	s p	10	d
Dearborn	1891	" 1	Aug	10	Massachusetts	6	2.45	t	y	w	m	s j	8	d
Desportes	1891	" 1	Aug	10	France	2	2.7	p	g r ru	w	m b	m	5	m
Drouard	1894	" 1	Oct. m Nov	10	France?	5	9.6	r obo obt p	y ru	w	t b	s p	5	m
Early Duchess	1892	" 1	m Sept	7-8	France	4-5	8	obo obt p	y r ru	w	t b m	v j	6-7	m
Edmonds	1889	" 1	Sept., Oct	10	New York	10	3.8	obo obt p	g y	w	m	s	5-6	m
Elizabeth (Manning)	1891	" 1	e Aug	10	Belgium	10	3.15	r obo	y ru	w	m	s p	8	d
Esperen	1891	" 1	Oct., Nov	10	Belgium	1	3.3	r obt p	y ru	w	t m	v	4-5	m
Fitzwater	1891	" 1	Oct	10	New York	7	7	obo obt p	y ru	w	b m	s	8-9	d m
Flemish	1891	" 1	m Sept	10	Belgium	3	10	o obt p	y ru r	w	m	s j	6-7	d
Fred Clapp	1888	" 1	1 Sept., Oct	10	Massachusetts	10	8.2	r obo p i	y	w	b m	v	7-8	d m
Giffard	1888	" 1	Aug	10	France	10	3.8	p	g y r	w	m	j v p	9	d m
Gray Doyenne	1888	" 1	Sept. Nov	10	France	7	3.1	ov obo p	ru	y w	b m	rich	8-10	d
Hardy	1888	" 1	1 Sept. e Oct	10	....	1	4	obo	g y ru	w	b m	v	8	d
Howell	1889	" 1	Sept., Oct	8-9	Connecticut	10	7.65	r p	y r ru	w	m	v	5-6	m
Jones	1889	" 1	Oct., Nov	8	Pennsylvania	7	2.65	obo p	y ru	w	g b	s v	5-6	d
Kieffer	1891	" 1	Oct. m Nov	10	Pennsylvania	6	5.1	r ov obt p	y r ru	w	g m	s p v	3-4	m
Kentucky	1891	" 1	Sept	10	Kentucky?	1	2.4	t obo	y ru	w	m g	m	3-4	?
Lawrence	1888	" 1	Oct., Dec	8	New York	4	5.25	obo obt p	y ru	w	m	s p	8-9	d m
Lawson	1889	" 1	m Aug	10	New York	2	5.2	obo p	y r	w	g b	s	3-4	m
Longworth	1891	" 1	m Sept	10	Ohio	5	4.5	obo t	y ru	w	br g	s p	5	m

Lucrative	1888	"	1	m Sept.	10	Europe	10	4.6	obo p	g y	w	m	s	8-9	d m
Marguerite	1889	"	1	Aug.	9	France	5	5	obt p	y g	w	t b	v	8	d
Marshall	1893	"	1	Oct.	10	New York	1	5.9	obo	y ru	w	b r	m	4-5	m ?
Millett	1891	"	1	Dec., May	8	Europe	10	8	obt p i	g y ru	w	f b	v	5-6	k
Mount Vernon	1891	"	1	Oct., Nov.	10	Massachusetts	8	4	r o v obt p	y ru	w	t b m	j v p	7-8	k m
Ogereau	1891	April 29		Oct., Nov.	8	Europe?	8	5.9	obo ob p	y r ru	w	b	v	6-7	m
Onondaga	1891	May	1	Oct., Nov.	10	Connecticut?	3	8.88	obo o p	y ru	w	b m	v p	7	m
Pitmaston	1891	"	1	Sept., Oct.	10	England	2	12.6	ob obo p	y ru	y w	m b	v	7-8	m
Reeder	1891	"	1	Oct. b Nov.	9	New York	1	4.6	r obt p	y ru	w	b m	v	7-8	d m
Rostiezer	1888	"	1	m Aug. m Sept.	10	Europe	7	2.4	obo p	y b ru	w	m b	s v p	10	d
Rutter	1892	"	1	Oct.	10	Pennsylvania	3	8	r p	y g ru	w	b m	s v	7	m
Seckel	1888	"	1	Oct.	10	Pennsylvania	6	3.6	obo	y b r	w	b m	s v	10	d
Sheldon	1890	"	1	Oct.	10	New York	1	6.8	r obt obo	y b ru	w	m	s v p	7-8	m d
Souvenir	1890	"	1	m Sept.	10	France	1	7.6	r obt p	y r	w	b m	j p	5-6	m
Sterling	1888	"	1	Aug.	10	New York	7	4.15	r t	y ru r	w	m	s	5-6	m
Summer Doyenne	1888	"	1	Aug.	10	Belgium	6	1.5	r obo	y b	w	t b m	s v p	5	d
Superfin	1891	"	1	Oct.	10	France	1	6.5	r p	g y ru	w	m	v	7-8	d
Victor	1891	"	1	Oct.	10	......	1	2.9	r obo p	y	w	t b m	s p	7-8	d m?
Wilder	1889	"	1	m Aug.	10	New York	1	4.5	ob p	y r	w	t	m	4	m
Winter Nelis	1888	"	4	Oct. m Jan.	10	Belgium	5	2.95	obo	y ru	w	t b m	s p	10	d m
Zache	1894	"	4	Nov., April	10	......	4	6	r o	y ru	w	g	s	2-3	?

QUINCES.

Quinces were sprayed with copper sulphate solution, one pound to fifteen gallons of water, in early spring, and with Bordeaux mixture when the fruit had set. All varieties escaped winter injury, except the Hong Kong, which was killed. This variety was planted here in 1888, and never either bloomed or fruited. Most kinds of bearing-age produced full crops.

Alaska is both vigorous and productive. Fruit roundish, slightly oblate, ribbed; basin broad, rather deep; cavity none; calyx nearly closed, segments long, reflexed; color golden yellow; flesh pale yellow, crisp. Not so large as the Orange, but in other respects it seems equal to that variety.

Meech bore a very full crop this season. The fruit is below medium in size, roundish, slightly oblate; basin narrow, deep, ribbed; calyx nearly closed, segments short; cavity very slight, ribbed; flesh pale yellow, firm, crisp. Very symmetrical in form.

Missouri is the largest variety on trial. Form roundish, somewhat irregular; basin broad, deep, ribbed; calyx open, segments long, leaf-like, reflexed, color rich yellow; quality very good. Season October and November.

Rea is of good appearance and large size. Form roundish oblate, ribbed; basin broad, rather deep; calyx closed, tips of segments reflexed; color golden yellow. A seedling of the Orange.

TABULATION OF QUINCES, 1899.

Name.	Planted.	Bloomed.	Ripe.
Alaska	1891	May 15	Middle of October.
Angers	1890		
Bourgeat	1895		
Champion	1888	May 14	
Fuller	1891	May 17	
Hong Kong	1888		
Meech	1888	May 16	Middle of October.
Missouri	1890	May 12	Middle of October.
Rea	1888	May 12	Early October.
Van Deman	1895	May 17	Middle of October.

Van Deman first fruited here last year, and this season bore nearly a full crop. Fruit roundish, slightly oblate; basin irregular, ribbed; cavity slight; color clear rich yellow; flesh pale yellow, crisp, firm, quality very good. Season middle of October.

PLUMS.

American and European plums came through the winter uninjured, except for a few trees of the latter species which were slightly frozen at the tips of new growths. A few of the Japanese varieties were quite badly frozen and in the case of a number of sorts a large per cent of the fruit buds were killed. Injuries to varieties of this species are mentioned on another page under notes on Japanese plums.

In addition to the use of copper sulphate solution early in the spring and Bordeaux mixture after the fruit had set, a number of varieties were sprayed from two to four times during the summer for the purpose of checking the brown rot, if possible. In the case of some varieties which were rotting badly one tree of a kind was sprayed and another of the some sort left unsprayed in order that the results of spraying might be more accurately determined. The copper sulphate was first used at the rate of one pound to three hundred gallons of water, but later the strength of the solution was increased, one pound to two hundred gallons being used. Rains occurred once or twice shortly after applications had been made and as soon afterward as possible the trees were again sprayed. Although the trees were sprayed thoroughly each time and as many as four applications made in the case of some kinds, the treatment made but little if any difference in the amount of rot. Fruit of sprayed trees continued to rot almost if not quite as badly as that of trees unsprayed. Conditions during the latter half of July and the first half of August were unusually favorable for the rot, hot

moist weather prevailing most of the time during that period, and this may in part explain the lack of success in attempting to control the disease by spraying.

Shot-hole fungus appeared on a few varieties during the season. Abundance, Burbank, Ogon, Simon and Yosebe were the kinds most affected. However, in the case of most varieties, spraying served to keep the foliage free from fungous attacks and the leaves held on well until fall.

In June a number of heavily loaded trees of several varieties were thinned, while other trees of the same kinds were left unthinned to serve as checks on results. Some varieties were thinned more severely than others in order that the effects of both ordinary and severe thinning might be observed. Records were kept of the kind of thinning, number of pounds of fruit removed in the case of each tree thinned, size of fruit at time of thinning, length of time required to thin, etc. It was expected that full notes of a similar nature would be taken when the fruit had ripened, but owing to the prevalence of rot this could not be done in the case of fall varieties. A detailed account of the experiment is therefore omitted. However, in a general way, it may be said that thinning in nearly every instance gave increased size of fruit. It was also observed that there was less rot on thinned than on unthinned trees.

EUROPEAN PLUMS.

Among the more productive of the European varieties were Archduke, Diamond, Grand Duke, Lombard, Middleburg and Victoria. The following are varieties which were not included in the report of last year:

Baker Damson.—Trees very upright, vigorous. Fruit small, roundish ovate, with a slight cavity and slender stem; apex marked by a small dot; color black; flesh greenish amber, juicy; fruit small, roundish, cling; quality good. Very good for culinary purposes, but as yet quite unproductive.

Early Red.—This variety was received from Prof. Budd of Iowa as Black Prune, but is probably Early Red according to Prof. Budd's description of that variety, while Nicholas, another of Prof. Budd's importations from eastern Europe, also turns out to be Early Red. The trees of Early Red are upright, slightly spreading, weak, thin growers. Fruit resembles Lombard quite strongly in appearance, but ripens at least two weeks earlier than that variety. Form oval; stalk three-fourths of an inch long, set in a slight cavity; suture rather obscure; bloom blue, slight; color purplish red; flesh firm, juicy, greenish yellow; flavor sub-acid, pleasant; quality good. Not considered promising.

Engle.—Fruit roundish oval; stalk rather short and stout, set in a narrow shallow cavity; suture somewhat obscure, half around; color yellow with faint traces of green; flesh firm, fine grained, yellow; pit oval, pointed, free; flavor sweet, rich; quality good. A good dessert variety which this season ripened August 2. The trees are vigorous, upright, slightly spreading.

G. No. 4.—Received from New York State in 1890, under letters and number given. Trees upright with roundish slightly spreading heads. Fruit nearly round; stem about three-fourths of an inch long, slender, set in a narrow rather deep cavity; suture broad, shallow; color very dark purple with numerous light specks; bloom blue, plentiful; pit nearly round, cling; flesh very firm, juicy, tender, pale amber; quality good. A poor bearer and seems to be of little value here.

White Queen.—Received through the Division of Pomology in 1890, and fruited here this season for the first time. The trees are upright, slightly spreading, vigorous. Fruit roundish ovate, slightly flattened at the base; stem about one inch long, curved, set in a slight, regular cavity; suture, a line half around; apex, a dot in a slight depression; color yellowish white, mottled and overlaid with light purple, becoming dark in exposed specimens; bloom heavy, whitish; flesh yellow, juicy, tender; pit small, plump, oval, cling; quality best. Ripe September 9.

JAPANESE PLUMS.

Burbank was uninjured in wood, but about twenty-five per cent of the fruit buds were winter killed. However, this variety set so many buds that in spite of the large number destroyed, the trees set too much fruit and required thinning.

Berckmans bore some fruit on grafts set in 1897. The fruit is roundish to roundish oblong; stalk three-fourths of an inch long, very stout, set in a broad shallow cavity; suture well marked, half around; color very dark red with many golden yellow dots; bloom slight, pinkish; flesh tender, juicy, yellowish; pit quite small, oval, cling; quality rather low. The shoots are olive green with many gray dots. Requires further testing.

Hale was badly frozen back and all of the fruit buds were killed. The trees were well cut back in pruning and made a strong growth this season. Kelsey was killed

to the ground. This variety is not hardy enough to carry its buds safely through even our ordinary winters, and consequently never matured any fruit here. Normand grafts two years old were killed.

Satsuma, which has heretofore been very productive, and apparently quite hardy here, was badly discolored in wood and all except a very few of the fruit buds were killed. Wickson was not injured in wood, but nearly all of the fruit buds were killed and no fruit was borne.

Willard is an upright, spreading, very vigorous grower. Fruit oblong with a stout stalk about three-fourths of an inch long; cavity deep; suture rather obscure; color bright red with light bluish bloom; flesh rather firm, whitish; flavor mild; quality poor.

TABULATION OF PLUMS, 1899.

ABBREVIATIONS.—Form—l, long; o, oval; ob, oblate; r, roundish. Color—b, black; g, greenish; p, purple; r, red; w, whitish; y, yellowish. Adhesion—c, cling; f, free; s, semi-cling.

Name.	Species.	Planted.	Vigor—Scale 1-10.	Bloomed.	Ripened.	Form.	Color.	Adhesion.	Weight of specimen in ounces.	Product—Scale 1-10.	Quality—Scale 1-10.
Abundance	Triflora	1895	9	Apr. 28	July 29	r o	r	c	1.9	8	7
Agen Prune	Domestica	1890	10	" 29	Sept. 5	o	p	f	.9	6	8
Archduke	Domestica	1890	10	May 1	" 9	r o	b	f	1.3	10	7
Arctic	Domestica	1890	10	Apr. 29	Aug. 17	r o	b	f	.8	10	5
Baker (Damson)	Domestica	1893	10	" 30	Sept. 9	r o	b	s	.4	1	6-7
Bavay	Domestica	1890	10	" 29	" 23	r	g y	c	1.6	6	10
Berckmans	Triflora	1897	10	" 29	Aug. 29	r	r	c	1.4	1	4-5
Bradshaw	Domestica	1890	9	May 1	" 17	o	p	f	1.8	8	6-7
Burbank	Triflora	1893	10	Apr. 29	" 13	r	r	c	1.9	10	6
Burbank 7	Domestica	1890	8	" 28	Sept. 1	r o b	g y	s	1.55	2	9
Coe	Domestica	1893	10	" 29	" 23	o	y	c	2.2	2	8
Czar	Domestica	1892	9	" 29	Aug. 10	r o	p	f	1	5	7
Diamond (Black)	Domestica	1892	10	" 29	Sept. 12	o	b	f	1.8	10	5-6
Early Red	Domestica	1888	7	" 30	Aug. 21	o	r	c	.95	1	7
Engle	Domestica	1892	8	" 29	" 2	r o	g y	f	.9	6	8
Field	Domestica	1892	10	" 29	" 17	o	p	c	1.55	3	7
French Damson	Domestica	1893	10	May 1	Sept. 19	r	b	c	.6	3	7
G. No. 4	Domestica	1890	10	" 1	" 5	r	p	c	1.62	2	7
Giant Prune	Domestica	1895	9	" 1	" 8	o	r	f	2.03	2	7
Grand Duke	Domestica	1890	10	Apr. 29	" 22	o	b	c	1.6	10	6
Kingston	Domestica	1890	10	" 28	" 12	o	b	s	1.5	9	6
Lincoln	Domestica	1890	9	" 30	Aug. 10	r o	r p	f	2.12	9	8-9
Lombard	Domestica	1889	10	" 29	" 5	r	p	c	1.2	10	6
Long Fruit	Triflora	1890	10	" 28	July 18	r	r	s	.45	8	4
Lyon	Domestica	1890	10	May 1	Aug. 19	r	y	f	1.7	2	8
Mariana	Cerasifera	1890	10	Apr. 29	July 28	r o	r	c	.7	9	3
Maru	Triflora	1890	8	May 1	Aug. 10	r	r	c	1.4	1	4
Middleburg	Domestica	1890	10	Apr. 29	Sept. 25	r o	r p	f	1	10	6-7
Monarch	Domestica	1893	10	" 29	" 25	o	p	f	1.5	6	7
Murdy	Domestica	1892	9	May 1	" 8	o	r p	f	2.55	8	8
Ogon	Triflora	1890	10	Apr. 28	July 25	r	y	f	.8	10	2-3
Orel 20	Domestica	1888	9	May 1	Aug. 13	l o	b	f	.55	1	5
Red June	Triflora	1890	10	Apr. 28	July 25	r o	r	c	1.1	10	6
Robinson	Angustifolia	1890	10	May 3	Sept. 2	r	r	c	.75	8	6
Shipper (Pride)	Domestica	1890	10	Apr. 29	" 5	r o	b	s	1.67	5	7
Shropshire (Damson)	Domestica	1890	10	" 30	" 19	r o	b	s	.45	8	6-7
Simon	Simoni	1888	5	" 28	Aug. 13	r	r	c	1.6	10	2
Spaulding	Domestica	1890	10	" 29	Sept. 1	o	g y	s	1.35	4	9
Victoria	Domestica	1890	10	" 29	Aug. 25	o	r	f	1.65	10	8
Wangenheim	Domestica	1890	10	May 1	" 29	o	b	f	.85	9	7
White Queen	Domestica	1894	9	" 1	Sept. 9	r o	y w p	c	1.7	1	9
Willard	Triflora	1894	10	Apr. 29	July 24	o	r	c	1	1	3
Wyant	Americana	1890	8	May 1	Sept. 11	r o	r	f	.7	4	7
Yellow Aubert	Domestica	1888	10	" 1	Aug. 28	o	y	c	1.8	3	5
Yellow Egg	Domestica	1893	10	Apr. 30	" 30	o	y	f	1.8	3	4-5
Yosebe	Triflora	1890	10	" 28	July 12	r	r	c	.5	8	2-3

GRAPES.

Results with grapes have been somewhat unsatisfactory this season. This was due to several causes, among which were injury by winter, several varieties being frozen to the ground and others more or less damaged: attack of both downy and powdery mildew, especially the latter, and a hard frost on the night of September 30, which caused the leaves to fall considerably and prevented some of the late ripening varieties from maturing properly.

Before the buds opened, the vines were sprayed with copper sulphate, one pound to fifteen gallons of water. For the powdery mildew liver of sulphur was used at the rate of three ounces to ten gallons of water. This solution was applied on the first appearance of the disease in early August. Two weeks later, downy mildew appearing also, the plants were again sprayed, copper sulphate being used for this application at the rate of one pound to two hundred and fifty gallons of water. These attacks of mildew were confined principally to hybrids with V. vinifera. The vines were quite free from the work of insects.

Adirondack was killed nearly to the ground by the freeze. It has not proven of value here. Black Eagle was also badly killed back, and bore only a few small clusters of fruit. It is a grape of good quality, but lacks vigor, productiveness and hardiness. Brighton set a fair crop of fruit, but most of it was badly coated with powdery mildew.

Campbell Early is one of the most promising of the new varieties. The vines are vigorous, hardy and productive. Bunches long, shouldered, moderately compact: berries large, firm, cling to stem well. Ripens with Moore Early, keeps well, and is of good quality.

Delaware and Diamond bore very full crops. Downing and Mills were frozen to the ground. Duchess was quite badly injured and bore but little fruit. Etta yielded a very large crop, but it is too acid and low in quality to be of much value. It is a white grape, borne in large, compact clusters.

Goldstein is a new black variety set in 1897. It proves very vigorous, hardy, and productive, but is of poor quality and shells badly. Guinevra and Josselyn 9 were among the more productive varieties. Guinevra is a large white grape of good quality, borne in medium to large compact clusters. Josselyn 9 is a dark purple grape of rather poor quality. The clusters are long, cylindrical, moderately compact.

Niagara was quite unproductive. The vines were somewhat injured by the winter, but made a strong growth of new wood this season. Pocklington came through the winter uninjured and bore a full crop. Rogers Nos. 24 and 30, and Secretary, were killed to the ground. Triumph, which is a southern grape requiring a long season, has usually failed to mature properly here, but this season ripened fairly well. However, the quality of the grape as grown in this section is poor and the bunches, although very large and compact, were rather unattractive in appearance because of the attack of powdery mildew.

Ulster and Woodruff set too much fruit, and this, together with the frost of September 30, prevented the ripening of more than a small part of the crop. Ulster is a red grape of good quality, with its berries in cylindrical, compact clusters. Woodruff is also a red grape. The bunches which are sometimes inclined to be small and imperfect were large and compact this season, but the quality was very poor.

TABULATION OF GRAPES, 1899.

ABBREVIATIONS.—Bunch: Form—c, compact; cy, cylindrical; r, roundish; s, shouldered. Berry: Form—o, oval; ov, ovate; r, round. Color—a, amber; b, black; g, greenish; p, purple; r, reddish; w, whitish; y, yellowish. Season: b, beginning; m, middle; e, end.

Name.	Species.	Bloomed	Ripened.	Received from.	Vigor—Scale 1-10.	Productiveness—Scale 1-10.	Quality—Scale 1-10.	Bunch. Form.	Bunch. Weight in ounces.	Berry. Form.	Berry. Size.	Berry. Color.
Adirondack	Lab. x Vin.	June 13	m Sept.	Ell. & Barry	6	1	8	cy s	2.55	o	6	b
Agawam	Lab. x Vin.	" 13	b Oct.	Hubbard	10	3	6	cy s	3	r	8-9	p b
Alice	Lab.	" 12	b Oct.	T. J. Dwyer	10	4	7-8	cy	4.1	r	4-5	r
Aminia	Lab. x Vin.	" 13	b Oct.	Hubbard	10	2	7-8	cy s	2.4	r o	7-8	b
Barry	Lab. x Vin.	" 10	m Sept.	Hubbard	9	3	6	r c s	2.5	r	6	b
Bell	Vul. x (Bour. x Lab.)?	" 8	m Sept.	Munson	10	10	8	cy s	3.5	r	7	w
Belvidere	Lab.	" 13	b Sept.	Agricultural College.	9	6	5	cy s	3	r	6	b
Berckmans	Vul. x (Bour. x Lab.)	" 9	b Oct.	Agricultural College.	8	5	8	cy s	2.9	r	4-6	r
Berlin	Lab.	" 10	m Sept.	Hosford	8	1	6	....	1.5	r	6	w
Black Eagle	Lab. x Vin.	" 15	m Sept.	Hubbard	4	1	8	cy c s	......	r	7	b
Brighton	Lab. x Vin.	" 13	m Sept.	Hubbard	10	4	10	cy s	4	r	6-7	p
Burnett	Lab. x Vin.	" 16	m Sept.	Ell. & Barry	8	3	7	cy s	4	o	6	b
Cambridge	Lab.	" 12	m Sept.	Barnhart	10	10	7	cy s	4.7	r	7	b
Campbell Early	Lab. x Vin.	" 14	b Sept.	Agricultural College.	10	10	8	cy s	7.85	r	9	b
Caywood 50	Lab.	" 10	m Sept.	Caywood	10	10	3-4	cy s	3	r	5-6	b
Centennial	Lab. x Vin.	" 13	e Sept.	Campbell	6	10	10	cy s	2.1	r	4	w
Challenge	Lab. x Vin.	" 8	b Oct.	Barnhart	10	2	3-4	cy s	1.4	r	3-4	r
Chidester 2	Lab.	" 13	m Sept.	Chidester	6	6	7	cy s	4.3	r	6	r
Chidester 3	Lab.	" 13	m Sept.	Chidester	9	1	7	cy s	1.35	r	4	r
Chidester 4	Lab.	" 14	m Sept.	Chidester	10	8	8	cy s	6.4	o	6	r
Clinton	Vul. x Lab.	" 8	b Oct.	Hubbard	10	10	4	cy s	2	r	3-5	b
Columbia	Vul. x Lab.	" 13	b Oct.	Ell. & Barry	6	8	5	r s	2.8	o	6-7	p
Columbian	Lab.	" 8	b Oct.	Farmer	10	8	4	r s	3.4	r o	10	r
Concord	Lab.	" 12	e Sept.	Home	10	7	6	cy s	5.3	r	7	b
Cortland	Lab.	" 8	b Sept.	Lambert	10	8	3	o s	7.6	r	6	b
Cottage	Lab.	" 8	m Sept.	Hubbard	10	7	5	cy s	3.6	r	6	b
Creveling	Lab. x Vin.	" 8	b Oct.	Hubbard	10	10	5-6	cy s	5	r	4-5	b
Delaware	Bour x. Lab.	" 13	m Sept.	Hubbard	7	10	10	cy s	2.3	r	3	r
Diamond	Lab. x Vin.	" 13	m Sept.	Chase	8	10	8	cy c s	4.65	r	7	w
Diana	Lab. x Vin.	" 13	b Oct.	Hubbard	7	1	7-8	cy	2	r	5-6	r
Dracut	Lab.	" 10	m Sept.	Hubbard	10	4	3	cy c s	5	r	8	r
Duchess	Lab. x Vin.	" 15	e Oct.	Hubbard	9	3	10	cy s	1.8	r o	4-6	w

Early Victor	Bour. x Lab.	June 13	m Sept.	Hubbard	10	8	8	cy s	3.6	r	4	b
Eaton	Lab.	" 15	m Sept.	Hubbard	10	4	4–5	cy s	4.25	r	7–9	b
Elaine	Lab. x Vin.	" 13	e Sept.	Engle	9	1	7–8			r	6–7	r
Elvira	Rip.	" 8	e Sept.	Hubbard	10	10	4–5	cy s	3.8	r	6	w
Empire State	Lab. x Vin.	" 12	m Sept.	Hubbard	10	6	8	cy s	3.8	r	4	w
Esther	Lab. x Vin.	" 13	e Sept.	Josselyn	8	5	7	cy s	4.8	r	7	w
Etta	Lab. x Vul.	" 10	b Oct.	Hubbard	10	10	4–5	r s	5.3	r	6–8	w
Geneva	Lab. x Vin.	" 15	m Sept.	Chase	10	8	5	cy s	3.2	o y	6	w
Golden Gem	(Bour x Lab.) x Vin.	" 8	b Sept.	Campbell	6	8	10	cy s	1.1	r	3	w
Goldstein	Lab.	" 8	e Aug.	Thompson	10	10	5	cy s	3	r	6	b
Guinevra	Lab. x Vin.	" 10	e Sept.	Engle	10	10	6	cy e s	6.4	r	6–8	w
Hall	Lab.	" 13	m Sept.	Hall	10	7	5	cy s	3.7	r	6	b
Hartford	Lab.	" 15	b Sept.	Hubbard	7	2	5	cy e s	6.4	r	6	b
Hayes	Lab.	" 13	m Sept.	Hubbard	8	1	7	cy s	1.5	r	4	w
Herbert	Lab. x Vin.	" 15	m Sept.	Hubbard	7	2	7	r s	3.6	r	8	b
Honey	Lab. x Vin.	" 12	e Sept.	Engle	8	6	7	cy s	2.85	r	6–7	w
Hosford	Lab.	" 13	m Sept.	Hosford	9	1	6	cy s	6.3	r	9	b
Iona	Lab. x Vin.	" 13	b Oct.	Hubbard	8	7	10	cy s	3	r	5	r
Isabella	Lab.	" 11	b Oct.	Hubbard	10	6	7–8	cy s	3	o	6	b
Ives	Lab.	" 9	e Sept.	Hubbard	10	10	4	cy s	3.15	r	6	b
Janesville	Lab.	" 8	m Sept.	Hubbard	10	1	4	r s	2.85	r	6	b
Jefferson	Lab. x Vin.	" 16	b Oct.	Hubbard	8	5	8–9	r s	3.4	r	5–6	r
Jessica	Bour. x Lab.	" 9	e Aug.	Hubbard	8	5	6	cy s	2.5	r	5	w
Josselyn 5		" 13	e Sept.	Josselyn	10	6	8	cy	3.3	r	7–8	w
Josselyn 9		" 13	b Oct.	Josselyn	8	10	4	cy s	3.4	r	6–8	p
Josselyn 10		" 13	e Sept.	Josselyn	10	1	6	cy s	1.6	r	6	b
Lady	Lab.	" 13	m Sept.	Josselyn	8	3	6	cy s	2.1	r	7	w
Lindley	Lab. x Vin.	" 14	e Oct.	Hubbard	7	5	7	cy s	3.2	r	5–7	r
Lutie	Lab.	" 10	m Sept.	Parry	9	8	4	cy s	5.85	r	8	r
Lyon	Lab.	" 15	b Oct.	Chidester	10	2	8–9	cy s	3.9	r	8–9	w
Mason	Lab. x Vin?	" 13	m Sept.	Mason	8	8	6–7	cy s	2.2	r	5–6	r
Massasoit	Lab. x Vin.	" 12	m Sept.	Hubbard	8	3	7	r s	3.9	r	7	r
Merrimac	Lab. x Vin.	" 10	e Sept.	Hubbard	7	3	7	cy	2.8	r	7	b
Michigan	Lab. x Vin.	" 16	e Sept.	Engle	10	1	5	cy s		r	6–7	w
Millington	Lab.	" 13	m Sept.	Palmer	6	1	5	r s	4.9	r	10	b
Monroe	(Bour. x Lab.) x Lab.	" 14	b Oct.	Ell. & Barry	10	3	6	cy s	4	o	6–7	b
Moore Early	Lab.	" 12	e Aug.	Hubbard	9	6	7	cy s	4.8	r	8	b
Moyer	Bour. x Lab.	" 12	b Sept.	Hubbard	8	4	5	cy s	1.6	r	4	r
Niagara	Lab.	" 13	e Sept.	Hubbard	10	1	5	cy s	4.4	r	7	w
Northern Light	Lab.	" 14	e Sept.	Bucke	6	8	7	cy s	3.8	r	4–6	w
Osage	Lab.	" 15	b Oct.	Stayman	10	1	5	r o	3	r	6–9	b
Owosso	Lab.	" 15	e Sept.	Ell. & Barry	10	3	4	r s	2.8	o	8	r
Ozark	Est.	" 15	b Oct.	Stayman	10	1	5	cy e s	3.8	r	6–9	b
Peabody	Vul.	" 11	m Sept.	Campbell	7	7	7	cy s	4.45	r	6	b
Perkins	Lab.	" 15	b Oct.	Hubbard	10	5	2	cy s	1.65	r o	6–7	r

TABULATION OF GRAPES, 1899.—CONCLUDED.

Name.	Species.	Bloomed	Ripened.	Received from.	Vigor—Scale 1-10.	Productiveness—Scale 1-10.	Quality—Scale 1-10.	Bunch. Form.	Bunch. Weight in ounces.	Berry. Form.	Berry. Size.	Berry. Color.
Pocklington	Lab.	" 10	b Oct.	Hubbard	9	10	6-7	cy s	5.2	r	6-9	w
Poughkeepsie	Bour. x Lab.	" 13	e Sept.	Hubbard	4	5	9	cy s	2.25	r	4-6	r
Prentiss	Lab. x Vin.	" 15	e Sept.	Hubbard	8	1	7-8	cy	.....	r	5-7	w
Presley	(Lab. x Vul.) x Lab.	" 9	m Sept.	Munson	9	8	5	cy s	7	r	5	r
Progress	Lab. x Vin.	" 13	e Sept.	Stayman	10	10	4-5	cy s	1.65	r	5-6	b
Pulpless	Lab. x Vin.	" 13	m Sept.	Engle	10	1	7	cy s	2.9	r	8-9	b
Requa	Lab. x Vin.	" 13	m Sept.	Campbell	9	7	8	cy s	4.55	r	7	r
Rochester	Lab.	" 13	m Sept.	Ell. & Barry	8	9	4	cy c s	4.55	o	5	r
Rockwood	Lab.	" 12	b Sept.	Josselyn	9	8	8	cy c s	6.4	r	6	b
Rogers 5	Lab. x Vin.	" 15	e Sept.	Hubbard	7	3	7	r	2.84	r	5-7	r
Salem	Lab. x Vin.	" 15	m Sept.	Hubbard	7	4	7	r s	4.05	r	8	r
Telegraph	Lab.	" 12	e Sept.	Hubbard	8	9	6	cy s	9	r	7	b
Triumph	Lab. x Vin.	" 16	b Oct.	Campbell	10	10	6-7	cy s	8.1	r o v	7-8	w
Ulster	Lab. x Vin.	" 8	b Oct.	Caywood	8	10	9	cy c	3.8	r	7	r
Vergennes	Lab.	" 12	b Oct.	Hubbard	8	8	8-9	cy s	3.8	r o v	7-8	r
Vesta	Lab. x Vin.	" 13	e Sept.	Engle	10	6	3	r s	3.9	r	7-8	w
Victoria	Lab.	" 14	e Sept.	Josselyn	8	1	7	cy s	4.45	r	5-8	b
Warder	Lab.	" 15	m Sept.	Huber	7	8	7	cy s	3.45	r	6	b
White Beauty	Lab. x Vin.?	" 15	e Sept.	Stayman	8	5	7	cy s	2.6	r	4-6	w
White Imperial	Lab. x Vin.?	" 10	b Sept.	Stayman	8	4	7	cy s	1.6	r	6	w
Wilder	Lab. x Vin.	" 13	e Sept.	Hubbard	7	4	7	cy s	2.9	r	7	b
Willis	Bour. x Lab.?	" 13	m Sept.	Campbell	9	1	5	cy s	2.6	r	6	w
Winchell	Lab. x Vin.	" 13	e Sept.	Ell. & Barry	9	8	9	cy s	3.6	r	6	w
Witt	Lab. x Vin.	" 13	b Oct.	Campbell	8	4	7-8	r s	2.3	r	5-9	w
Woodruff	Lab. x Vin.	" 8	b Oct.	Scott	10	10	5	r s	8	r	7-8	r
Worden	Lab.	" 10	m Sept.	Hubbard	10	10	8	cy c s	5.25	r	8	b
Wyoming	Lab.	" 10	m Sept.	Hubbard	9	1	4	cy s	1	r	6	r

APPLES.

Nearly all varieties of apples of bearing age yielded well this season. Even some of the newer sorts which had not borne before produced full crops. Early in April, the trees, with the exception of a few rows, were sprayed with copper sulphate, one pound to fifteen gallons of water. The rows left untreated when this first spraying was done were given an application of Bordeaux mixture just before the buds opened. This latter treatment where tried has usually given good results by way of preventing the attack of apple scab fungus on the fruit stalks at the time of blossoming, and it was the purpose to further test the effectiveness of this practice. But conditions were not very favorable for the disease at blossoming time last spring and there appeared to be no difference in favor of this treatment as compared with the earlier use of the copper sulphate solution. However, in ordinary seasons there is little doubt but that it pays to spray just before the flower buds open and in some instances it may even be the means of saving the crop. After the blossoms had fallen and again about two weeks later, the trees were sprayed with Bordeaux mixture and Paris green. These several sprayings served to hold fungous diseases well in check, but did not prove so effectual against the work of the codling moth. A few of the late ripening varieties were quite wormy. Doubtless one or two later sprayings would have considerably lessened the damage done by the insect.

Below are given descriptions of varieties not heretofore described in the sub-station reports. They are mostly new sorts which this season proved sufficiently productive to give some indication of their probable worth.

Arnold.—Tree vigorous, upright, rather spreading. The fruit is oblate, ribbed; cavity broad, deep, usually russeted; basin deep, slightly corrugated; stalk one and one-fourth inches long, slender; color yellow, sometimes with a brownish red cheek, and usually with patches and network of russet; calyx small, closed; calyx tube cup-shaped; flesh yellowish, firm, mild, sub-acid, rich, pleasant; quality very good. Season November to March.

August (crab).—Tree vigorous, with roundish head. Fruit roundish conical, with a deep, abrupt cavity, and a narrow, deep basin; stem one and one-fourth inches long, slender; calyx closed, segments long, tips reflexed; calyx tube conical; color yellow; washed with light red, profusely covered with broken stripes of dark dull red, and dotted with many light dots; flesh yellow, juicy, crisp, acid. Season August and September.

Buckingham.—Tree upright, slightly spreading, vigorous. Fruit oblate, conical; cavity broad, deep, slightly russeted; basin deep, corrugated, somewhat irregular; stalk medium, one-half inch long; calyx closed; calyx tube conical; color greenish yellow, shaded and splashed with two shades of red; flesh yellowish white, tender, breaking, juicy; flavor sprightly sub-acid. Season November to February.

Carlough.—Tree vigorous with a roundish, spreading head, and reddish brown shoots. Fruit roundish conical; cavity medium, slightly russeted; basin small, shallow; stalk three-fourths of an inch long, slender; calyx small, closed; calyx tube short, conical; color greenish yellow with a faint brownish red cheek; flesh white, tender, juicy, with a mild, sub-acid, pleasant flavor. Ripe in November and apparently a long keeper.

Colton.—Tree vigorous, upright, spreading. Fruit ovate, inclined to conical, slightly ribbed; cavity narrow, regular; basin shallow, ribbed; stalk stout, three-fourths of an inch long; calyx closed; calyx tube funnel shaped; color greenish yellow, often with a brownish red cheek, and sprinkled with many greenish dots; flesh white, fine-grained, rather tender, with a sprightly, sub-acid, very pleasant flavor. Season August. Promising as an early dessert apple.

Cullin.—Tree upright, spreading, slightly lacking in vigor. Fruit roundish, oblong, narrowing toward eye; cavity broad, deep, russeted; basin medium, abrupt, corrugated, somewhat irregular; stem slender, one inch long; calyx closed, usually to a point; calyx tube long, funnel shaped; color yellowish green, rather faintly shaded with brownish red at the base and sprinkled with many light dots toward the crown; flesh firm, crisp, juicy; flavor sprightly, sub-acid. Ripe in January.

Dickinson.—The tree is an upright, slightly spreading, fairly vigorous grower, with rather slender, yellowish brown, slightly downy shoots. Fruit roundish, oblong, inclining to conical; cavity narrow, rather shallow, basin shallow, corrugated; stalk stout, three-fourths of an inch long; calyx short, closed; calyx tube conical; color light

yellow, shaded, splashed and mottled with bright red and sprinkled with light dots; flesh whitish, tinged with red next to the skin, crisp, tender; flavor brisk, sub-acid. Ripe in November.

Early Ripe.—Tree vigorous, with an upright, slightly spreading, compact head. Fruit oblate, somewhat ribbed, with a broad, deep, russeted, plaited cavity, and a shallow, plaited basin; stalk stout, one inch long; calyx small, closed; calyx tube funnel-shaped, short; color greenish yellow with russet dots and patches; flesh white, tender, quite juicy, mild, sub-acid, pleasant. Season August.

Excelsior (crab).—Tree upright, vigorous, with stout, dark brown shoots. Fruit roundish, slightly oblate; cavity broad, regular; basin shallow, plaited; stalk stout, one inch long; calyx irregular, closed; calyx tube conical; color pale yellow, well overlaid with bright red; flesh whitish, juicy, very tender; flavor sub-acid. Season August and September. A very handsome fruit of quite good quality.

Family.—A vigorous, upright, spreading grower. Fruit oblate; cavity, broad, deep, slightly russeted; basin broad, rather deep, plaited; stalk rather slender, three-fourths of an inch long; calyx small, closed; calyx tube broadly conical; color greenish yellow, shaded, striped, and splashed with dull red and sprinkled with many large, light dots; flesh white, tender, juicy, sub-acid, mild, aromatic. Season November to February.

Fink.—Tree an upright, vigorous grower. Fruit small, oblate; cavity medium, very regular, russeted; basin shallow, broad, corrugated; stalk moderately stout, one inch long; calyx medium, open; calyx tube long, funnel shaped; color yellow with a brownish red cheek, sprinkled with a few light dots; flesh whitish, fine-grained, compact, aromatic, sprightly, sub-acid. Season December to May.

Florence (crab).—Tree upright, spreading, vigorous. Fruit small, oblate; cavity regular, broad, deep; basin broad, ribbed, shallow; stalk slender, one inch long; calyx large, nearly closed, segments long, reflexed; calyx tube conical; color clear yellow more or less striped with red and dotted with a few grayish dots; flesh yellowish white, tender, juicy, crisp, acid. Season September. Inclined to overbear and the fruit is apt to be small and not well colored because of this tendency.

Gavet Pippin.—From Nova Scotia. Scions received from the Division of Pomology, Washington, D. C., in 1895. Fruit oblate with a broad, deep cavity, lined with greenish russet; basin broad, deep, ribbed; stalk medium, one-half inch long; calyx partly open; calyx tube large, conical; color greenish yellow, sometimes with a faint red blush; flesh white, tender, fine grained, mild, pleasant. Shoots reddish brown, downy. Season September and October.

Gibb (crab).—Tree vigorous, with a roundish, upright head. Fruit oblate, inclining to conical with a shallow corrugated cavity; basin broad, very shallow, corrugated; stalk stout, three-fourths of an inch long; calyx large, nearly closed; calyx tube long, cylindrical; color clear pale yellow, sometimes with a faint blush; flesh yellowish, firm, crisp, juicy, sprightly. Season August. Poor in quality and too light colored for a crab.

Hargrove.—Tree vigorous, upright, slightly spreading. Fruit roundish conical; cavity rather narrow; medium depth; basin shallow, plaited; stalk rather slender, three-fourths of an inch long; calyx small, open; calyx tube funnel shaped; color greenish yellow sometimes with a faint brownish red blush; flesh white, firm, mild, sub-acid. Ripe in November.

Hawley.—Tree vigorous, with a round head. Fruit large, roundish, slightly oblate with deep cavity and a medium somewhat plaited basin; stalk medium, three-fourths of an inch long; calyx closed or party open; calyx tube long, conical; color yellow with many grayish specks; flesh white, tender, juicy, mild, sub-acid, very pleasant. Season early September.

Indiana.—Tree vigorous, upright, spreading. Fruit roundish, flattened at ends; cavity narrow, russeted; basin broad, shallow, slightly corrugated; stalk medium, three-fourths of an inch long; calyx partly open, segments short; calyx tube conical; color yellow, shaded and splashed with red, and sprinkled with russet dots; flesh white, tender, mild, sub-acid, pleasant. Season December to April.

Jacob.—Tree fairly vigorous, upright, slightly spreading. Fruit large, oblate, conical; cavity broad, deep; basin deep, abrupt; stalk medium, three-fourths of an inch long; calyx open; calyx tube conical; color yellow with a brownish red cheek, often considerably russeted; flesh white, firm, sweet, ripe in November.

Jelly (crab).—Tree upright, spreading, vigorous. Fruit roundish with an abrupt narrow cavity and a broad, regular basin; stalk slender, one and one-fourth inches long; color pale yellow, well overlaid with bright red, and sprinkled with gray dots; flesh white, crisp, juicy, sprightly, sub-acid. Season September and early October.

Kinnard.—Tree vigorous, with a spreading, roundish head. Fruit large, roundish oblate, inclining to conical; cavity broad, deep, russeted; basin deep, furrowed; stalk short; calyx closed or slightly open; calyx tube obtusely conical; color yellow, well overlaid with dark red; flesh yellowish white, tender, juicy, mild, rich, aromatic. If this variety proves productive it should be of value for market because of large size and attractive appearance. Ripe in December.

Picket.—Tree vigorous, upright. Fruit of medium size, roundish oblate, inclining to conical; cavity broad, shallow, russeted; basin narrow, abrupt, slightly plaited; stalk very short; calyx closed or slightly open; calyx tube funnel shaped; color yellow, blushed and obscurely striped with dark red and sprinkled with light dots; flesh whitish, juicy, mild, sub-acid, almost sweet. Season December to February. An apple of good quality and good appearance.

Prolific Sweet.—Tree upright, slightly spreading, somewhat lacking in vigor. Fruit large, roundish conical, with a very broad, deep, russeted cavity; basin rather deep, abrupt, corrugated; stalk stout, one and one-fourth inches long; calyx closed, lobes long, reflexed at tips; calyx tube long, conical; color yellow, flesh white, a little coarse, sweet. Season late August and early September.

Pryor Red.—Tree upright, very vigorous. Fruit medium, roundish oblate; cavity small, abrupt, irregular; basin small, shallow, plaited; stalk stout, one-half inch long; calyx small, closed or partly open; calyx tube funnel-shaped; color greenish yellow, shaded with red and striped with dark crimson; flesh yellowish, juicy, fine grained, mild, sub-acid. Season January to March.

Red Russet.—Tree moderately vigorous, upright, spreading. Fruit small, roundish with a medium round cavity; basin round, regular; stalk rather stout, three-fourths of an inch long; calyx partly open, tips of segments reflexed; calyx tube short, conical; color red, well overlaid with cinnamon russet, flesh white, firm, juicy, sprightly, sub-acid. Season November to March. Fair for dessert purposes, but does not appear promising for market, because of small size, and rather unattractive appearance.

Summer Lievland.—Tree an upright, vigorous grower. Fruit roundish oblate; cavity narrow, regular; basin broad, plaited; stalk one inch long, medium; calyx closed, tips of segments reflexed; calyx tubes funnel-shaped; color greenish yellow with a few splashes of light red on exposed side; flesh white, tender, fine-grained, sub-acid, pleasant. Season August.

Thompson 29.—Tree vigorous, upright, slightly spreading. Fruit roundish, inclining to conical; cavity medium, regular, russeted; basin narrow, abrupt, corrugated; stalk moderately stout, three-fourths of an inch long; calyx open, segments reflexed; calyx tube conical; color greenish yellow sprinkled with white dots; flesh white, tender, fine grained, mild, sub-acid. Season October.

Townsend.—Tree vigorous, with an upright, compact head. Form roundish oblate, slightly conical; cavity broad, deep, basin rather shallow, corrugated; stalk medium, one and one-fourth inches long; calyx small, closed; calyx tube short, conical; color light yellow, splashed and striped with red; flesh white, tender, mild, sub-acid, pleasant. Season September.

Whinnery.—Tree vigorous with a roundish, upright, compact head. Fruit roundish, conical, frequently oblique; cavity regular, rather deep, russeted; basin shallow; corrugated; stalk medium, one inch long; calyx small, closed; calyx tube funnel-shaped; color light yellow, shaded with bright red and sprinkled with russet dots and patches; flesh white, tender, fine grained, sub-acid, pleasant. Season December to February.

TABULATION OF APPLES, 1899.

ABBREVIATIONS.—Month—b, beginning; e, end; m, middle. Form—c, conical; i, irregular; o, oblate; ob, oblong; ov, ovate; r, roundish. Color—g, green; r, red; ru, russet; s, striped; w, white; y, yellow. Texture—c, crisp; d, dry; f, firm; j, juicy; t, tender. Flavor—a, acid; m, mild; s, sweet. Use—c, cider; d, dessert; k, kitchen; m, market.

Name.	Planted.	Vigor.	Bloomed.	Ripe.	Season.	Weight in ounces.	Form.	Color.	Texture.	Flavor.	Quality, Scale 1 10.	Use.
Arnold	1890	9	May 4	November	Nov. Mar.?	7	o	y r	f	m	8	d k m
Alexander	1892	8	" 4	m September.	Sept.	8.55	o c	g y r	t c	m	6	k m
Bailey Sweet	1888	7	" 4	e September.	Nov. Mar.	9.1	r	r	t	s	7-8	d k
Battullen	1888	10	" 6	November	Nov. Mar.	3.5	r o	y r	t	a	6-7	d k m
Borovinka	1888	10	" 2	m August	Sept.	6.25	r o	y r	t	a	5	k m
Bottle Greening	1890	10	" 4	November	Nov. Feb.	5.45	o c	g y r	t	m	7-8	d
Bough	1888	10	" 6	m August	Aug.	7.5	r c	y	t	s	9-10	d k
Bradford	1890	9	" 3	December	Dec. Mar.	3.8	r c	g r	f c	m	4	m
Buckingham	1892	10	" 6	November	Nov. Feb.	6.3	o c	g y r	t j	a	7	d m
Carlough	1892	10	" 6	November	Nov. Mar.?	4.85	r c	g y r	t j	m	7	d
Chenango	1888	10	" 8	e August	Aug. Sept.	5.5	ob c	y r s	t	m	8	d
Cogswell	1888	9	" 5	November	Nov. Mar.	6.75	r c o	y r	t c	m	5-6	d m
Colton	1888	9	" 3	e August	Aug. Sept.	4.1	c ov	g w	t j	m	6-7	d
Cornell	1890	8	" 6	e September.	Sept.	6.2	r c	y r	t	m	7	d
Crain	1888	10	" 4	December	Dec. Mar.?	2.8	o	y r	f	a	6	k
Cullin	1890	8	" 6	January	Jan. April?	6.1	r ob	g y r	f c j	a	5-6	m
Day	1891	9	" 4	b September.	Sept. Oct.	6.25	r c	y ru	f t	m	3-4	k
Decarie	1890	10	" 8	b September.	Sept.	8.5	r c	r	t	m	5	k
Dickinson	1889	8	" 4	November	Nov. Feb.?	5.2	r ob c	y r	t c	a	5	m
Dyer	1888	8	" 3	b September.	Sept. Oct.	7.65	r o	y ru	t	m	9	d
Early Ripe	1891	10	" 4	b August	Aug.	3.9	o	g y ru	t j	m	7	d
Early Strawberry	1888	10	" 4	m August	Aug.	2.65	r c	y r	t j c	a	8	d k
Fall Pippin	1888	10		October	Oct. Dec.	11	r	g y r	t	m	7-8	d m
Family	1891	10	May 4	November	Nov. Feb.?	4.75	o	g y r	t j	m	6	d m
Fanny	1890	10	" 5	b September.	Sept.	5.5	r o	y r	t	m	7	d m
Fink	1892	9	" 1	December	Dec. Dec.	3.2	o	y r	f	a	4-5	m
Gano	1891	10	" 1	December	Dec. Mar.?	5.6	r c	g y r	t	m	5	m
Gavet	1895	7	" 6	m September.	Sept. Oct.	7.2	o	g y	t	m	7	k
Gideon	1890	10	" 3	e September.	Sept. Jan.	6	r ob c	y r	f c	a	5	k m
Gill	1892	9	" 6	November	Nov. April?	8.6	r o c	y r	f	m	4-5	m
Gloege	1888	9	" 3	November	Nov. Mar.	5.65	ov	y ru	c t	m	4	k
Golden Russet	1888	10	" 1	December	Dec. April	3.9	r	y ru	f	m	7-8	d m
Gravenstein	1892	10	" 4	b September.	Sept.	7	r o	y r	t c	a	8	k m

Grimes	1890	8-9	"	4	December	Dec. Mar.	4.5	r o b	y	f e t	m	8-9	d
Grosh	1890	7	"	3	m September	Sept. Oct.	5.8	r o	g y r	e	m	6	d k
Haas	1892	8	"	4	b September.	Sept. Oct.	6.4	o e	g y r	t	a	5-6	m
Hagenkopt	1888	10	"	6	m September	Sept.	7.25	r e	y r	f	a	5	m
Hargrove	1892	10	"	2	November	Nov. Mar.	3.5	r e	g y r	f	m	4-5	m
Hawley	1888	10	"	6	b September.	Sept.	10	r	y	t j	m	8	d
Hubbardston	1888	10	"	4	November	Nov. Jan.		r e	y r	t e	m	8	d m
Hurlbut	1892	10	"	4	October	Oct. Dec.	4.7	r	y r s	f	m	7	d
Indian?	1892	10	"	8	November	Nov. Feb.	6.6	r e	y r	f e	m	4-5	m
Indiana Favorite	1892	10	"	9	December	Dec. Apr.	4.5	r o	y r	t	m	6	d
Iowa Keeper	1891	10	"	3	December	Dec. Dec.	4.45	o	g y r	f	m	4-5	m
Jacob	1890	8	"	6	November	Nov. Feb.	8	o e	y r ru	f	s	6	d m
Jefferis	1888	8	"	3	b September.	Sept.	6.25	r o e	y r s	t	m	10	d
Jersey Sweet	1888	9	"	4	e August	Sept.	5.25	r	y r s	t	s	8	d k
Jonathan	1888	9	"	4	November	Nov. Mar.	4.4	r e	y r	e t j	a	10	d k m
Keswick	1888	6	"	4	b September.	Aug. Sept.	5	r o	w y	e	a	5-6	k
Kinnard	1892	10	"	4	December	Dec. Mar.	7.7	r o	y r	t j	m	7-8	d m
Lawver	1890	10	"	6	January	Jan. May	5.5	r	y r	f e	m	6-7	d m
Limber Twig	1892	9	"	4	December	Dec. April	3.5	r o	g y r s	f j	a	4-5	m
Longfield	1892	9	"	2	m September	Sept. Oct.	5.05	r e	y r	e t	a	5	k m
Lou	1890	9	"	4	e July	July, Aug.	4.03	r ov	y r	e t	a	4	k
Louise	1890	9	"	4	November	Nov. Jan.	5.25	r	g w r	e t	m	7-8	d m
Lowell	1890	10	"	5	b September.	Sept. Oct.	9	ob	y	t j	m	7-8	d m
Loy	1890	8	"	5	m October	Oct. Nov.	5.6	o	y r s	f e	a	5-6	k m
Maiden Blush	1892	9	"	4	b September.	Sept. Oct.	5.8	o	y r	t	m	6-7	m k d
Marmalade	1888	10	"	4	e August	Sept. Oct.	6.05	r o	y r s	e	s	3-4	?
Mason Orange	1890	9	"	6	November	Nov. Jan.	8	r ob	y r	e t	m	7	m k
McIntosh	1890	10	"	4	October	Nov. Feb.	6.9	r ob	y r	t	m	7-8	d m
Munson	1890	9	"	5	b September.	Sept.	3.6	o	y	t e	s	6	d k m
Nero	1890	9	"	2	November	Dec. May	4.1	r o	y r	f e	m	6-7	d m
Northfield	1890	10	"	5	September	Sept. Dec.	7.15	r o	y r	e t	m	5	k m
Oakland	1888	9	"	3	October	Nov. Mar.	5.5	o	y r	t	m	7-8	d m
Oldenburg	1892	8	"	2	m August	Aug. Sept.	6.45	o	y r	e	a	4-5	k m
Ontario	1890	9	"	5	December	Dec. April	9	o	y r	t	m	6-7	d m
Peck	1888	9	"	6	November	Nov. Mar.	7	r	y r	t	m	8-9	d m
Peter	1890	8	"	4	b September.	Sept. Oct.	6.1	o e	y r	t j	a	5-6	k m
Picket	1888	8	"	8	December	Dec. Feb.	4	r o	y r	f	m	6-7	m
Pine Stump	1892	8	"	2	November	Nov. Mar.	2.15	r	r ru	t	m	6-7	d
Primate	1888	10	"	4	e August	Aug. Sept.	5	r eo	y r	t	m	9	d m
Prolific Sweet	1890	7	"	4	e August	Aug. Sept.	5	r e	y	f	s	5	d
Pryor Red Seedling	1888	9	"	4	November	Dec. Mar.	5.2	r o	g y r s	t	m	5-6	m
Quince, Cole	1892	10	"	4	b September.	Aug. Sept.	8	r e	y	t	a	4-5	k
Rambo	1890	10	"	6	October	Oct. Dec.	4.6	r o	y r	t	m	7-8	d k
Ramsdell Sweet	1888	10	"	4	November	Nov. Feb.	4.25	ob e	y r s	t	s	6-7	d m
Red Aport	1888	10	"	3	m September	Sept. Nov.	9	o e	y r	e	a	5	k m
Red Astrachan	1888	10	"	2	e July	Aug.	5.6	r o e	g y r	e	a	6	d k m

TABULATION OF APPLES, 1899.—CONCLUDED.

Name.	Planted.	Vigor.	Bloomed.	Ripe.	Season.	Weight in ounces.	Form.	Color.	Texture.	Flavor.	Quality—Scale 1-10.	Use.
Red Dettmer	1888	10	May 3	b September	Sept. Oct	7.65	r o c	y r s	c t j	a	6	k
Red June	1892	10	" 4	b August	August	3.7	o c	r	f	a	8-9	d m
Red Russet	1890	9	" 6	November	Nov. Mar	3.1	r	r ru	f j	m	6	d
Rhode Island	1888	10	" 4	November	Nov. Mar	7	r o	g y	t c	a	9	d k m
Rosenhager	1888	10	" 4	m October	Oct. Dec	11.5	r o c	y r	t c	a	5-6	k m
Roxbury	1890	10	" 4	November	Nov. June	4.6	r o	y ru	f c j	m	7-8	d k m
Scarlet Cranberry	1891	9	" 4	December	Dec. April	4	o	g y r	f j	m	5	m
Sheriff	1891	10	" 4	December	Dec. Mar	6.5	r ob c	g r	t	m	7	m d
Shiawassee	1888	10	" 4	October	Oct. Dec	5.3	r o	y r	t c	m	8	d
Somerset	1893	8	" 4	e August	Aug. Sept	3.2	c	y	t c	a	6	d ?
Stark	1888	10	" 3	December	Dec. May	8.8	r ob c	g y r s	f c	m	4-5	m
Stuart	1890	10	" 6	November	Nov. Jan	4.5	r o	g y r	c t	a	5-6	k
Stump	1889	9	" 4	b September	Sept. Oct	3.8	r c	w r	t	m	6	k
Summer Lievland	1890	10	" 2	m August	Aug	3.25	r o	g y r	t	m	7	d
Summer Pearmain	1888	10	" 4	m September	Sept	4.6	ob	y r	t	m	10	d
Summer Rose	1892	9	" 4	b August	Aug	2.9	r o	y w r s	t j	m	8	d
Tolman	1888	9	" 6	November	Nov. Mar	5.25	r o	y	f	s	7	k m
Thaler ?	1888	10	" 3	b August	Aug	5.7	ob	y r	t c	a	5	k m
Thompson 29	1894	10	" 5	October	Oct. Nov	4	r c	g y	t	m	5-6	k
Titovka	1888	7	" 2	m August	Aug. Sept	7.9	ob c	g y r	c t	m	5-6	k m
Townsend	1890	10	" 6	e August	Aug. Sept	6.7	r o c	y r s	t	m	7	d
Washington Strawberry	1890	9	" 3	e August	Aug. Sept	11.1	o c	y r s	c t	a	7	m
Water	1890	8	" 6	November	Nov. Dec	3.4	r o	w y r	t	a	5	d k m
Wealthy	1890	8	" 3	b September	Sept. Oct	7	r o	y r s	f	a	6	m
Whinnery	1890	10	" 4	December	Dec. Feb	4.45	r c	y r	t	m	7	d
Winter Streifling	1888	9	" 3	b September	Sept	8.85	r o	y r s	t	a	4-5	k m
Yellow Transparent	1888	10	" 5	e July	Aug	5	r	y	t	a	7	k m
York Imperial	1892	10	" 6	November	Nov. Feb	3.8	o	y r	f	m	6-7	d m
Zolotoreff	1890	8	" 4	m August	Aug	7.45	r	y r s	f c	m	5	k m
Zuzoff	1890	9	" 6	b September	Sept. Oct	4	r c	y r	t	m	4	k m

TABULATION OF CRAB APPLES, 1899.

Pyrus baccata; including actual and supposed hybrids.

ABBREVIATIONS.—Month—b, beginning; e, end; m, middle. Form—c, conical; i, irregular; o, oblate; ob, oblong; ov, ovate; r, roundish. Color—g, green; r, red; ru, russet; s, striped; w, white; y, yellow. Texture—c, crisp; d, dry; f, firm; j, juicy; t, tender. Flavor—a, acid; m, mild; s, sweet. Use—c, cider; d, dessert; k, kitchen; m, market.

Name.	Planted.	Vigor.	Bloomed.	Ripe.	Season.	Weight in ounces.	Form.	Color.	Texture.	Flavor.	Quality.—Scale 1-10.	Use.
August	1890	8	May 2	m August	Aug. Sept.	4.1	r c	y r s	c t	a	5	k
Dartmouth	1890	10	" 2	e August	Aug. Sept.	1.62	o	r	c	m	10	d k
Excelsior	1890	10	" 3	e August	Aug. Sept.	4.5	r o	y r	t	a	6	k m
Florence	1890	8	" 2	m August	Aug. Sept.	1.1	o	y r s	t c	a	6	k
Gibb	1890	8	" 1	b August	Aug.	1.9	o	y	f c	a	2	c
Jelly	1890	10	" 4	m September	Sept. Oct.	1.25	r	y r	c j	a	5-6	k
Martha	1890	8	" 4	e August	Aug. Sept.	1.7	o	y r	c t	a	9-10	k
North Star	1890	8	" 2	b August	Aug.	.9	r o	y r	t	m	4-5	k
No. 1 New	1890	10	" 5	m August	Aug.	7.75	r	g y s	t	a	7	d m
No. 2 New	1890	10	" 3	e August	Sept.	1.1	o	g y r s	t	a	5	k m
Quaker	1891	10	" 3	m September	Sept. Jan.	2	r ov	y r	c	m	4	k
Transcendent	1893	9	" 3	e August	Sept.	1.8	r ob	y r	c	m	8	k m
Whitney 20	1890	10	" 1	m August	Aug.	2.45	r	y r	c	m	9	d k m

NUTS.

There are now thirty-seven varieties of nuts in the sub-station collection, including almonds, chestnuts, filberts, hazelnuts, pecans, and walnuts. A number of new varieties were put out last spring.

ALMONDS.

Snelling was badly injured by the winter. It is a hard-shelled variety planted in 1892. Previous to last winter it seemed vigorous and hardy and bore some fruit. Two new trees of a hard-shelled kind were set last spring.

CHESTNUTS.

Comfort.—Tree upright, spreading, moderately vigorous. Nuts large, of good quality. Only a few specimens borne. Resembles Paragon somewhat.

Japan Giant.—Tree a slow, spreading grower, somewhat lacking in vigor. The nuts are very large, but lack quality.

Numbo.—Nuts large, smooth, attractive. Not equal to Paragon in quality. The trees were set in 1892 and have grown very slowly.

Paragon.—This seems to be the most valuable variety which has thus far fruited. Trees upright, spreading, quite vigorous. Nuts large, of good quality. A good crop was borne this season.

Spanish.—Trees winter-killed badly. An upright, spreading, moderately vigorous grower. Nuts of large size, with heavy shuck. Quality very good.

FILBERTS.

Cosford matured some fine specimens this season. The nuts are long, thin-shelled, of fine quality. Bush vigorous and hardy.

Kentish Cob, planted in 1892, has as yet borne no fruit. Last winter the catkins were all frozen. The bush itself seems quite hardy.

WALNUTS.

Japan Walnuts.—Juglans Sieboldii again bore a full crop of nuts. The trees are rapid, strong growers and may have value for ornamental purposes rather than for the fruit, which does not equal our native butternut or walnut in flavor and quality.

Persian or English walnuts have grown very slowly here and as yet have borne no fruit. A number of new varieties were put out last spring, but judging from the behavior of those several years planted it is very doubtful whether they will prove of value here.

S. H. FULTON.

South Haven, Mich., December 1, 1899.

REVIEW OF PROFESSOR BANG'S WORK WITH CONTAGIOUS ABORTION.

BY CHARLES E. MARSHALL.

Special Bulletin 13.—Department of Bacteriology and Farm Hygiene.

There is evidence that cattle raisers who have been troubled with epizootic or contagious abortion will be interested in learning anything reliable which will throw light upon this dreaded disease. Our knowledge previous to two or three years ago, when Professor Bang's work became known, was so limited that an intelligent and assuring answer could not be given to the oft-repeated question which came to the Experiment Station, "What shall we do to eradicate abortion from our herds?"

Since Prof. Bang's first work, other facts have accumulated to establish the validity of his position. Now we wish to place emphasis upon his recommendations and also to briefly review the various stages of his experiments. In justice to Professor Bang, it may be said that what lessons may be drawn from his experiments, nothing satisfactory can be accomplished unless the utmost care be observed in carrying out his suggestions. Accuracy and detail are the essential factors in fighting contagious abortion. Nothing can be gained by an indifferent effort in wiping out a disease of this nature.

In this review I have drawn from Prof. Bang's articles and also a review of some of Professor Bang's works by C. W. Sorensen in the "North British Agriculturist."

It is allowed that sporadic cases of abortion may assume an enzootic form, but the most common form is that which compels us to conclude that it is of an infectious order.

After giving a short history of epizootic abortion and a careful consideration of Nocard's investigations, the author proceeds with his own experiments, which were carried out with the assistance of Mr. V. Stribolt.

That the causal agent might be discovered, it was thought necessary to select a pregnant cow from an affected herd, in fact a cow showing signs of impending abortion. Such an animal was purchased on the 19th of December, 1895. She was five years old and had been served with the bull on the 21st of May. Since the 15th of December there had been premonitory symptoms of abortion. The cow was slaughtered and the genital organs removed with great care to the laboratory.

"The external surface of the uterus was normal. The os uteri was firmly closed and the cervical canal was filled with the normal thick mucus. After disinfection of the serous covering of the uterus by burning, I made a section through the uterine wall: when the mucus membrane was divided, we saw between that and the foetal envelopes an abundant odorless exudate—a dirty yellow, somewhat thin, pultaceous material of a slimy, somewhat lumpy character. At some places where the fluid constituents had run out, the exudate was of a semi-solid nature; its reaction was alkaline. When it was allowed to stand in a glass it separated into two strata, namely: superiorly a reddish-yellow cloudy serum, and at bottom a thick greyish-yellow precipitate."

"On cutting through the chorion we saw under that a thin, clear, apparently gelatinous substance with very fine membranes running through it; closer examination showed that this was the fine connective tissue lying between the chorion and the allantois, saturated with an oedematous exudate. This was present over the entire extent of the foetal envelope and formed a layer one and one-half centimeters in thickness. The allantoic fluid was natural in appearance, thin, yellowish and containing only fine flocculi. Nothing abnormal was observed in connection with the amniotic fluid. The umbilical cord was oedematous. The size of the foetus and the degree of development of the hair on it indicated an age of seven months. It was

quite fresh, and on sections it showed no striking alteration. The pericardium contained a little reddish fluid: the intestinal mucous membrane was, perhaps, rather redder than ordinary; the spleen was in a very slight degree swollen, and the blood was fluid."

Upon examining a cover-glass preparation made from the yellowish exudate, there was revealed a small bacterium apparently in pure culture. The bacteria were abundant, some free and most of them clustered in heaps within cells which were frequently distended. The appearance of the bacteria within cells resembled cocci closely, but single individuals conformed to the shape of a bacillus whose body contained one, two or three round or elongated granules. It was with difficulty that this microorganism was cultivated, but it was eventually found to grow upon serum-gelatine-agar and it behaved very peculiarly to oxygen.

Twenty-one cases of epizootic abortion were examined and found to correspond very nearly to the case already described. The bacillus was found in nearly every examination made: sometimes the bacilli were very abundant and at other times they were found with difficulty. Associated with the abortion bacillus were various other kinds of bacteria which had penetrated after opening the uterus, but the abortion bacillus was easily isolated by means of agar serum. In a foetus forwarded, the bacilli of abortion were found in pure culture, and in another case the bacilli were found in the blood, medulla oblongata, fourth stomach and intestinal contents. In two cases of dead mummified foetus the bacilli were also recognized.

"This would indicate that the abortion bacilli do not always entail the expulsion of the foetus, but that the result is sometimes merely the death of the foetus."

From the above cases of mummified foetus, the marked vitality of the abortion bacillus was illustrated. "The first cow had probably been bulled in December, 1894, or in January, 1895, and the death of the foetus had probably taken place five months later, that is to say, in May or June, 1895. The bacilli had therefore remained for at least nine months longer in the uterus, and, nevertheless, they were alive." This cow was slaughtered on the 16th of March, 1896, when the germs were still found and capable of cultivation: the foetus was about five or six months along. In the second case the cow was bulled on the 19th of March, 1896, and was slaughtered on the 15th of February, 1897. The foetus had died in September, 1896, and the bacilli were alive five months later. Again, the vitality of the bacillus was proven by collecting some of the uterine exudate in sterile test-tubes on the post mortem of the first case. Four, six and seven months later the bacillus was found to be alive in the exudate. The vitality of this bacillus explains why a cow which has once aborted has a tendency to abort again, unless a careful disinfection is made of the uterine cavity, and also the persistency of the disease when once established.

Having found a bacillus which in all of its habits indicated its causal action in abortion, and having found it generally present in all the cases examined, the crucial test of reproducing the disease was then attempted. It was known that several veterinary surgeons had already reported that they had succeeded in doing this by introducing vaginal secretion or part of the afterbirth of aborted cows into the vagina of pregnant cows. "It is also extremely likely that the agent of infection is, as a rule, taken in a similar way, the external parts of the genital organs of the cow being brought in contact with infected objects during her sojourn in the byre. When the bull conveys the disease, one must assume that infection takes place during copulation."

Experiments I and II.—Two cows were purchased from a stock in which abortion was unknown, one cow was four years old and the other seven. They were bulled on the 14th and 16th of January, 1896, respectively. On the 14th of April, 1896, was injected into the vagina of each a rather large quantity of pure culture of the abortion bacillus. Injections were repeated on the 2nd of May and the 4th of June, lest the first injection should miscarry. On the 24th of June one of the cows aborted. The foetus was five months old and had been dead for some days. The bacilli of abortion were found.

The seven-year-old cow was slaughtered on the same day, that there might be an opportunity to examine the still unopened uterus. An edema was present and more striking than in the four-year-old. The foetus was fresh and evidently alive when the cow was slaughtered. The bacilli of abortion were found as in the first instance.

"*By both these experiments we have furnished the complete proof that the bacillus discovered by us is the cause of epizootic abortion.*"

These experiments did not establish the period of incubation, but it was the opinion of the investigator that it was dated from the first injection and that it was about ten weeks.

Experiment III.—This animal was six years old and was affected with chronic pyelo-nephritis. She was purchased in October, 1896, and was not known to be pregnant till several months later. On the 19th of January a pure culture was introduced into the vagina as in the above Experiments I and II. On the 9th of April the cow gave birth to a small but apparently full time calf. However, there were present in the cow's uterine cavity the same catarrhal conditions which were present in the aborting cows.

Experiments IV and V.—Two sheep were inoculated in the same manner as the above cows, the 29th of January, 1897; one was a three-year-old white ewe tupped on the 7th of November and the other a two-year-old black ewe tupped on the eleventh of November. The white ewe gave birth to two living lambs on the third of April. 147 days after copulation. The lambs thrived quite well, but were probably born too soon. The catarrh of abortion was present in the uterine cavity and the bacilli were abundant. The black ewe was killed on the same date, but the result was negative.

Experiment VI.—"It now appeared to us to be of interest to determine experimentally whether it was possible to introduce abortion bacilli into the uterus by way of the blood stream. On the 6th of March, 1897, we therefore injected into the jugular vein of a pregnant ewe eighteen c.c. of a bouillon serum culture. (In the opinion of the seller, the ewe was due to lamb at the beginning of April.) On the following day the sheep would not feed, respiration was very hurried, and it had a temperature of 40.9 C. On the 18th of March the ewe gave birth to two lambs, which were small but healthy and developed quite well. The afterbirth came away after an hour; the entire chorion and also the cotyledons were deep red and covered with a rich red flaky exudate. The membranes were a little edematous. The exudate contained very large numbers of abortion bacilli, of which we obtained beautiful cultures."

Experiment VII.—A small ewe received eight c.c. of a bouillon serum culture. April 1, 1897, into the jugular vein. Time of lambing was unknown. Fever on second day was slight, but temperature was 41 C. on third day. On the 8th of April she gave birth to a small living lamb. Abortion bacilli were found in discharge.

Experiment VIII.—A pregnant mare, eight years old, received 25 c.c. of a pure culture in the jugular vein on April 1, 1897. There was a slight fever after injection. On the 29th of April she gave birth to a small living foal, which died May 1st. Abortion bacilli were present in the after discharge. In this case there is no doubt that the birth was premature, and it also agrees very closely with the two previous experiments and goes to show that the bacillus of abortion may be conveyed through the blood.

How the bacilli of abortion has been disseminated is now a very interesting question to solve, inasmuch as the mode of infection has been attributed to several sources and the true micro-organism of the disease is known. Owing to the long period of incubation, the theory that the bull has been the agent in disseminating the bacilli, and that he assumes the most important rôle in keeping the disease alive, has more weight.

In February, 1897, a Swedish estate owner applied to Professor Bang for advice in the management of the dreaded disease, which had broken out in his recently imported herd of Jerseys. Professor Bang recommended that the generative organ of the bull be disinfected with a one and a half per cent solution of lysol, by injecting about one quart of it, with a rubber syringe, under the prepuce before and after service. A year later the Swedish gentleman reported that the trouble had disappeared entirely. The number of cases reported on the Swedish estate may be tabulated according to Mr. Sorensen's review as follows:

	Imported.	Home bred.	Total.
"1893	4	0	4
1894	15	0	15
1895	76	4	80
1896	12	39	51
1897	4	25	29
1898	0	1	1"

Only one cow aborted which had not been exposed before the adoption of Professor Bang's method of treatment, and this the owner claims was clearly a case of non-contagious abortion.

Previous to 1897, on this Swedish estate, every means was exerted to prevent the spread of the disease. The aborting cows were removed from the stalls and the stalls

were thoroughly disinfected. The hind quarters of the affected cows were thoroughly disinfected. Every summer the entire stable was disinfected. Special cattlemen and special milkers were appointed for the aborting cows. Much time intervened before the aborting cows were put to the bull. Although the disease was partially allayed, it was quite evident that it was by no means eradicated.

Considerable more evidence was collected by Professor Bang from his colleagues in Denmark. All of which points to the important part the bull plays in spreading the germs of abortion.

In one case a farmer let his bull to a neighbor who had contagious abortion in his herd. Although this farmer had had no abortion for eleven years, every cow that was served by that bull thereafter aborted. The bull was sold, cows disinfected with lysol, and for two years there have been no cases of abortion.

In another case, the farmers are designated as A, B, C. In the spring of 1897, A, who had sold his own bull, obtained a service of B's bull for his fifteen cows, which had aborted during the year past. B also gave the services of his bull to C. "Neither B nor C had ever had a case of abortion hitherto, but in 1898 their cows began to calve prematurely." Nine of B's and twelve of C's cows had aborted previous to July, 1898.

Still another case, two farmers having about twenty-five cows each, although they were in the habit of keeping a bull for each herd, had reached the point where one had become dependent on the other for the services of his bull. One of them had been troubled with abortion, while the other who let his bull had been free. However, the following year, after lending his bull to his neighbor, the farmer who had experienced no cases of contagious abortion, had fifteen cows abort.

Such evidence as this indicates very plainly the relation of the bull to the spread of the disease. No trouble is experienced in disinfecting the bull, especially if the solution of lysol is first warmed. Besides disinfecting the bull, it is necessary to disinfect the uterus of the cows. The cows should first be isolated, the placenta should be removed and destroyed not later than the day after calving. The uterus should be repeatedly disinfected with a one-half per cent solution of lysol. It is also necessary, inasmuch as the germs are scattered about the barn and on the fodder, that the barn and all of its contents be disinfected. It will be remembered that Prof. Bang has practically demonstrated that the germs of this disease may find entrance to the body through various avenues. If this is so, stringent care and acute watchfulness, with a proper knowledge of disinfection, will be the best remedies in wiping out contagious abortion when once established.

To fight contagious abortion, it becomes necessary, therefore, to disinfect the bull before and after service, to disinfect the uterus and vagina of the cow, as well as the cow herself, to isolate the cow, to disinfect the stable with its utensils. For methods and disinfectants which may be used for carrying out the fight, I refer the reader to bulletin No. 172 of this station. In disinfecting the uterus of the cow, it would be well for the stock-man to secure a competent veterinarian to instruct him, inasmuch as the process will have to be repeated frequently. The stock-man will be able to do the work himself if once shown how.

CHARLES E. MARSHALL.

September 10, 1899.

As this goes to press, more recent work by Professor Bang confirms the foregoing.

December 22, 1899. C. E. M.

THE PRODUCTION AND MARKETING OF WOOL.

BY HERBERT W. MUMFORD.

Bulletin 178.—Farm Department.

January, 1900.

SUMMARY.

1. The outlook for fine wools is bright, due to the almost universal falling off in numbers of Merinos kept not only in Michigan and the United States, but in nearly every wool growing country.

2. It is very doubtful indeed if the American wool grower can ever afford to ignore the ultimate value of the carcass producing the fleece.

3. Mutton growing, with wool as an incidental product, will continue to be a profitable industry.

4. Every pound of wool consumed in the United States can be profitably grown here.

5. Breed and feed affect the value of wool from the manufacturer's standpoint. Indiscriminate crossing is unprofitable. A sheep poorly nourished cannot produce a healthy fleece.

6. The manufacturer buys wool on the basis of its true value for manufacturing purposes. The grower, the local dealer, the commission man and the scourer should each make an honest effort to satisfy his reasonable demands.

7. Through established market prejudice against Michigan wools, for which prejudice the wool growers of Michigan in former years are largely responsible, and through the lack of care in preparing Michigan wools for the market, the wool growers of Michigan are losing $200,000.00 annually.*

8. A small linen, or flax or hemp twine, is best for tying wool.

(The sample of twine accompanying this bulletin is linen and can be recommended for tying wool.)

9. Coarse, heavy paint marks should be avoided in marking sheep.

10. More and better wool can be secured by early shearing.

11. Loose, bulky fleeces sell best in the market.

12. Country wool buyers can greatly aid in an effort to bring Michigan wools up to the standard, by buying wool on its merits. By offering an advance in prices for wools properly grown and prepared for the market, and by discriminating against poorly grown, dirty or poorly tied fleeces.

13. Commission men and wool manufacturers must buy Michigan wool on its merits. They must pay as much for wools grown in Michigan as those grown elsewhere, provided, of course, they are equal in condition and quality.

14. The first thing necessary is for growers to remove objectionable features of Michigan wool; the next to insist that dealers and manufacturers buy wool on its merits.

15. Avoid lime and sulphur as a sheep dip.

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* This is a low figure. Estimating the annual wool product of Michigan at 10,000,000 pounds, a conservative estimate, and the reduction of price 2 cents per pound, much less than the actual reduction, we get the $200,000.00 loss.

THE PRODUCTION AND MARKETING OF WOOL.

During the past six or eight years we have been impressed with the fact that but very few farmers in Michigan, even among those who keep sheep, have been paying much attention to the wool product of their flocks. Flock owners have rightfully complained of the low prices for all grades of wool without having confidence enough in the future to apply their intelligence and energy toward the improvement of their flocks along wool-bearing lines. It is safe to say that very much the same condition exists throughout the United States.

Present conditions point to a more satisfactory market, especially for some grades of wool. It seems, therefore, that this is an opportune time to place before our farming population a few investigations recently made by the writer concerning the wool industry, together with certain facts relating to the growth of wools.

CAN THE KEEPING OF SHEEP FOR THE PRODUCTION OF WOOL ALONE BE MADE PROFITABLE?

It is very doubtful whether the time will ever come when the keeping of sheep for the production of wool alone can be made profitable in Michigan or in many localities in the United States.

Wool growing upon such a basis must, in the future, be confined to localities remote from the great meat consuming centers, where farmers are unprovided with rapid transportation to these centers, or where the cost of transportation of mutton would be so high as to render the carcass of little or no value.

A moment's consideration would suggest that wool growing under such conditions could only be made profitable upon cheap lands where the herding of large flocks would be possible and where the climate and other conditions would be favorable to the development of sheep and the healthy growth of the wool fiber.

We can conceive how present conditions might be so changed as to render sheep husbandry profitable, if the wool product only were taken into account. It is not probable, however, that we shall ever see a repetition of conditions which existed earlier in this century. It is not probable that the price of the finer grades of wool will go so high that the breeder, even of that class of sheep, can afford to entirely overlook the ultimate value of the carcass for the block.

We expect to see, in the future more than in the past, two classes of sheep raisers in Michigan and throughout the United States. One class will keep sheep for the primary object of producing mutton, with wool as a secondary or incidental product; the other will aim to produce wool first and the mutton second. Whether the production of wool or mutton should be the aim of the breeder will depend upon his personal preference and upon his capacity. Some sheep raisers will prefer the mutton breeds, others the Merino.

The great mass of sheep owners will vacillate from breeding grades of the one to breeding grades of the other as conditions favorable to the production of wool or mutton at the time seem to render the one or the other more profitable.

It is not hard to see that the ranchman who can run large flocks of sheep in bands, and who has at his command an almost unlimited grazing ground, can produce wool more economically that the general farmer who keeps a flock and looks upon it simply as an incidental contributor to his income.

The owners of small flocks, then, soonest feel the effects of depression and are most apt to quickly dispose of their flocks after one or two unprofitable years.

A careful study of the following pages of this Bulletin will, I trust, impress upon the minds of flock owners the desirability of choosing one or the other of these lines of sheep husbandry and adhering to it year after year.

Not until the wool growers of this country are content to do this will the sheep industry, viewing it either from the purely wool producing or the mutton producing standpoint, ever take its place in the front rank of the great sheep growing countries of the world.

We believe future conditions will bear us out in the statement that there will be very

few years when the man who has a flock of either mutton or wool sheep of good quality, who pursues careful and painstaking methods in handling them, will fail to secure a net profit.

There is a promising outlook for the American farmer who economically produces wool and mutton. I doubt if we shall again see the time when the flock master can secure a net profit from his flock unless he makes a thorough study of the industry, knows what he is trying to do, and how he is to accomplish his ends, and is willing to settle upon a policy of breeding and rigidly adhere to it.

May I venture to suggest here that one of the greatest sources of loss to the American farmer has been his vacillating from one line of breeding to another, from one rotation of crops to another, and from one system of farming to another.

Use all of the means at hand to decide the wisest line of sheep husbandry to pursue under your conditions, and then do not deviate from it without the best of reasons. Remember that a constant, persistent and settled policy is best.

In connection with this subject the question naturally arises,—Can sheep husbandry be made profitable by disregarding entirely the wool product? In some few favored localities such a course of sheep husbandry may be made profitable, but under ordinary conditions the wool product contributes materially to the net income from the flock. In some instances breeders of mutton sheep have realized as much for their wool as the men who have been keeping sheep primarily for the wool which they produce. In making such a claim it should not be forgotten that the American markets in the past have not been glutted with a large supply of the medium and coarse grades of wool, while the scarcity of fine wools, owing to the common stock of the country being largely Merino grades, has not been apparent until within the past few months, although a few of the breeders of Merino sheep have persistently prophesied that former conditions would return, and that the grading up of flocks for the production of the finer grades of wool would again profitably engage the attention of American sheep men.

Fashion in the manufacture of woolen fabrics, which has always been a potent factor in the price of different grades of wool, has seemed to encourage the growth of medium and coarse wools. While the future of the wool industry will be settled by conditions almost entirely beyond the control of the growers of this country, still everything points to a brighter prospect for the wool grower than for several years past, and especially for the producer of Fine Delaine wools.

WORLD'S WOOL PRODUCTION.

The number of sheep in the world in 1894, according to S. N. D. North, was 571,163,062, and the amount of wool produced from the above sheep was 2,692,986,773 pounds, showing the average weight of fleece per head to be 4.7 pounds.

WOOL PRODUCT OF THE UNITED STATES.

From the same authority we learn that in the United States, during the same year, there were 45,084,017 sheep, producing 325,210,712 pounds of wool. By this we see the United States produces about one-eighth of the world's supply of wool. The average weight of fleece in the United States is 7.21 pounds; over two pounds per head above the world's average.

For the last twenty years the number of sheep in the United States has varied from approximately 40,000,000 to 50,000,000; the latter figure was exceeded in 1884, while in 1894 the number was estimated at 45,048,017.

Current prices for wool and mutton, combined with other conditions, which have made the production of one or the other of these products unprofitable, have caused this variation in the number of sheep kept and a similar variation in the amount of the mutton and wool produced. It has not been due to an over production of wool, for statistics show that never has home grown wool excelled or even equalled the consumption of wool in the United States.

No one can consistently say that we ought not to produce at home every pound of

wool consumed within our borders. The natural adaptability of many parts of the country for sheep raising suggests that we should, in every way possible, so adjust our farming operations, and our commercial and economic conditions, that the farms in the United States can produce at least all of the wool needed for home consumption, and that at a fair profit. From statistics furnished in the Wool Book for 1895, issued by the National Association of Wool Manufacturers, we learn that 453,048,456 pounds of wool were consumed in the United States during the year 1894. The wool produced in the United States during the previous year, which would naturally contribute to such consumption, amounted to 348,538,138 pounds. This shows that we produce little more than three-fourths of the wool consumed. Since it is a well known fact that the per capita consumption of wool in the United States has steadily increased from 4.49 pounds in 1840 to 9.07 pounds in 1890, it is clear that wool growers have a prosperous future before them, if only they will give more careful attention to growing, preparing for market, and to developing markets for their home grown products.

An advance in prices of wools tends to stimulate the industry. More wool is grown, but the manufacturer is obliged to pay higher prices for the raw material. It is difficult for clothiers to get a corresponding high price for manufactured goods so that the usual result is that manufacturers substitute, where possible, part cotton. The consumer gets his clothing just as cheap, but does not get all-wool goods. We have urged sheep growers in the United States to grow all the wool consumed in the United States. We would go still farther and call attention to the vast undeveloped markets for manufactured products. When we remember that of the inhabitants of the world there are 250,000,000 who do not wear clothes, with 100,000,000 more who wear only about one-half as many as they should, we can see great opportunities ahead in the way of markets for manufactured goods. Perhaps woolen goods would not be suitable,—then let garments manufactured from cotton and other fibres be used, leaving a clearer field for the wool producer who must now compete in a measure with producers of vegetable fibres grown at a minimum of cost.

By referring to the table below it will be seen that the average weight of fleece for Michigan in 1894-1895 was 6.01 pounds, a trifle over a pound per head below the average for the United States.

There is no good reason why the average weight of fleece for Michigan should not be as great as the average for the United States. If Michigan does not come up to the standard it is more the fault of the farmers and sheep breeders than of any lack of favorable conditions, either of climate or locality.

The table below will be interesting to Michigan wool growers.

Table showing number of sheep, number of pounds of wool, and average wool per sheep in Michigan from 1878 to 1898:

******Table compiled from Vols. 1 to 20, inclusive, of Farm Statistics of Michigan.*

	No. of sheep.	No. pounds of wool.	Average per head.
1878-79	1,670,790	8,666,467	5.19
1879-80	1,828,580	9,582,034	5.23
1880-81	1,965,952	10,724,107	5.45
1881-82	2,137,232	11,577,455	5.42
1882-83	2,240,965	12,737,343	5.68
1883-84	2,374,555	13,375,803	5.63
1884-85	2,453,897	13,827,542	5.63
1885-86	2,365,085	13,344,596	5.64
1886-87	2,128,049	12,362,799	5.81
1887-88	2,088,492	12,589,289	6.03
1888-89	2,039,974	12,451,103	6.10
1889-90	1,945,382	11,983,765	6.16
1890-91	1,947,258	11,732,395	6.20
1891-92	1,937,849	12,234,435	6.31
1892-93	2,014,630	12,641,745	6.27
1893-94	2,068,063	12,692,920	6.14
1894-95	2,040,698	12,267,007	6.01
1895-96	1,752,414	10,814,366	6.17
1896-97	1,333,127	8,392,742	6.30
1897-98	1,260,295	8,207,594	6.51

* From Farm Statistics 1898-99, just received, we learn that the number of sheep in the State is 1,366,353, yielding a total of 9,053,918 pounds of wool or an average of 7 pounds per head.

This table exhibits two important facts:

First, Taking the last twenty years into consideration we had the largest number of sheep in 1884, and the smallest number in 1898. There was not quite so much wool produced in 1898 as in 1878. This leads us to the conclusion that *Michigan farms are not overstocked with sheep.*

Second, There has been an almost unbroken improvement in the average amount of wool per head for the last twenty years. The causes for this improvement will be discussed in the subsequent pages of this Bulletin.

Table showing total Number of Sheep, total Number of Pounds Wool and Weight of Fleece per Head in Michigan by counties, compiled from Farm Statistics of Michigan, 1897-98.

Counties.	No. of sheep.	No. pounds of wool.	Average per head.
Alcona	1,632	8,804	5.39
Alger	....	....	....
Allegan	22,809	140,889	6.18
Alpena	1,957	12,883	6.59
Antrim	2,051	13,120	6.40
Arenac	937	6,197	6.61
Baraga	12	35	2.92
Barry	38,944	235,124	6.04
Bay	1,817	11,885	6.54
Benzie	392	2,862	7.30
Berrien	15,514	100,150	6.46
Branch	49,369	297,135	6.02
Calhoun	52,037	325,581	6.26
Cass	28,244	184,627	6.54
Charlevoix	1,860	11,317	6.08
Cheboygan	732	5,283	7.22
Chippewa	1,581	8,728	5.52
Clare	1,904	12,814	6.73
Clinton	46,322	282,037	6.09
Crawford	140	968	6.91
Delta	567	3,106	5.40
Dickinson	171	1,069	6.25
Eaton	54,759	342,079	6.25
Emmet	969	5,724	5.91
Genesee	43,196	286,503	6.63
Gladwin	760	5,049	6.64
Gogebic	....	....	....
Grand Traverse	1,463	10,874	7.43
Gratiot	33,908	198,357	5.85
Hillsdale	46,519	282,343	6.07
Houghton	21	124	5.90
Huron	23,344	159,929	6.85
Ingham	50,879	343,712	6.76
Ionia	42,466	274,815	6.47
Isabella	17,466	110,778	6.34
Isle Royal	....	....	....
Jackson	52,434	350,377	6.68
Kalamazoo	31,896	211,416	6.63
Kalkaska	630	4,239	6.73
Kent	24,484	157,843	6.45
Keweenaw	....	....	....
Lake	1,502	11,813	7.86
Lapeer	43,755	311,516	7.12
Leelanau	866	6,072	7.01
Lenawee	51,399	337,099	6.55
Livingston	49,272	344,397	6.99
Luce	92	490	5.33
Mackinac	302	1,608	5.32
Macomb	24,878	173,898	6.99
Manistee	1,092	7,622	6.98

Table showing total number of Sheep, etc.—CONCLUDED.

Counties.	No. of sheep.	No. pounds of wool.	Average per head.
Marquette	181	1,182	6.53
Mason	1,620	10,414	6.43
Mecosta	6,468	44,418	6.87
Menominee	640	4,291	6.70
Midland	4,712	26,750	5.68
Missaukee	795	5,343	6.72
Monroe	13,348	75,423	5.65
Montcalm	13,264	83,588	6.30
Montmorency	296	1,960	6.62
Muskegon	3,404	22,506	6.6
Newaygo	8,645	54,147	6.26
Oakland	48,668	335,673	6.90
Oceana	5,050	33,858	6.70
Ogemaw	2,252	15,728	6.98
Ontonagon	56	370	6.61
Osceola	6,813	47,891	7.03
Oscoda	691	5,608	8.12
Otsego	44	248	5.64
Ottawa	6,814	39,720	5.83
Presque Isle	1,166	6,002	5.15
Roscommon	98	510	5.20
Saginaw	15,674	95,907	6.12
St. Clair	20,748	121,426	5.85
St. Joseph	24,305	150,244	6.18
Sanilac	27,483	181,967	6.62
Schoolcraft	22	108	4.91
Shiawassee	42,894	280,099	6.53
Tuscola	27,989	190,891	6.82
Van Buren	20,461	133,355	6.52
Washtenaw	79,059	576,432	7.79
Wayne	6,021	37,091	6.16
Wexford	1,761	12,022	6.83
Totals	1,260,295	8,207,594	6.51

By studying the above figures it will be seen that the ten counties producing the greatest amount of wool are Washtenaw, Eaton, Jackson, Calhoun, Lenawee, Ingham, Branch, Livingston, Oakland and Hillsdale, in the order named. These ten counties contain nearly one-half the sheep, and produce approximately one-half of the wool grown in Michigan. All the sheep raisers of Michigan know that the number of sheep in the above counties could be doubled without overstocking the farms of those counties. In other words, we believe it would be an advantage to the farms and a source of profit to the farmers were the present number of sheep in Michigan all grown in the ten leading sheep counties. We can easily see what a wide field there would be left in other sections of the State, equally adapted to sheep growing, for the development of the sheep and wool industry.

While the number of sheep and the amount of wool produced has suffered a great depression there has been a greater proportional falling off in the production of the finer grades of wool.

We are indebted to Michigan wool buyers for the following data concerning the present character and extent of the Michigan wool product:

Table showing amount and character of wool clipped from Michigan sheep during 1899. (The numbers over the columns refer to questions below the table.)

	1.	2.	3	4.	5
Allegan	100,709	98,209	78,629	11,256	31,281
Alpena	25,000	25,000	15,000	....	....
Arenac	1,700	1,700	1,430	50	35
Benzie	9,000	9,000	9,000	....	....
Berrien	50,000	49,000	50,060	3,500	29,200
Barry	268,000	266,500	200,626	74,393	66,033
Branch	364,500	345,900	196,939	73,458	152,625
Cass	337,600	324,000	337,600	39,070	126,550
Clinton	818,000	754,250	600,420	179,941	269,416
Calhoun	938,151	858,290	686,571	213,696	424,537
Charlevoix	1,000	1,000	950	50	750
Eaton	245,257	201,582	156,694	25,064	53,984
Emmet	3,500	3,500	3,500	1,750	....
Grand Traverse	18,450	10,400	8,450	....	....
Gratiot	213,000	210,250	172,300	15,950	82,750
Genesee	270,030	242,530	232,877	44,836	79,760
Huron	241,400	230,900	237,400	6,861	37,850
Hillsdale	572,742	523,792	865,608	320,801	227,130
Ingham	306,500	291,500	244,700	127,940	146,582
Ionia	251,800	140,400	231,600	34,890	69,790
Isabella	158,000	155,500	158,000	4,907	54,500
Iosco	9,000	3,000	8,700	300	150
Jackson	343,000	297,020	247,300	131,967	119,767
Kent	378,479	350,329	354,218	49,221	69,930
Kalamazoo	520,000	427,500	365,333	114,500	172,250
Lapeer	536,079	429,079	399,249	93,520	44,650
Lenawee	409,093	268,093	95,336	45,250	135,670
Livingston	548,500	371,300	430,880	183,291	236,041
Macomb	332,500	288,500	232,366	137,333	86,250
Monroe	82,146	82,146	72,146	....	7,621
Mecosta	28,000	28,000	27,970	....	600
Midland	8,000	8,000	7,840	....	....
Montcalm	275,500	264,100	260,140	73,925	105,025
Muskegon	150,000	150,000	150,000	....	....
Newaygo	36,350	19,114	20,800	5,360	3,267
Ottawa	40,800	40,800	29,040	4,000	7,160
Oceana	52,000	50,700	52,000	1,250	900
Osceola	69,341	64,950	64,841	2,250	5,900
Oscoda	12,000	11,000	12,000	2,400	....
Oakland	506,000	430,000	386,190	133,800	318,733
Saginaw	210,712	150,162	180,310	7,796	47,350
Sanilac	211,900	189,900	201,379	18,130	38,076
St. Clair	158,500	140,300	150,595	6,855	44,708
St. Joseph	206,000	201,940	201,730	23,333	127,300
Shiawassee	277,000	262,250	199,250	73,916	115,666
Tuscola	317,891	257,200	264,353	22,849	79,846
Van Buren	120,120	99,946	120,120	10,000	46,810
Wayne	30,000	30,000	28,650	3,100	13,875
Washtenaw	952,552	573,592	635,416	473,856	386,026
Wexford	10,000	10,000	10,000	....	3,500
Totals	12,025,802	10,242,124	9,696,446	2,696,615	4,069,844

QUESTIONS ASKED LOCAL WOOL DEALERS IN MICHIGAN.

1. How many pounds of wool have you purchased during the season of 1899?
2. How much of this do you think was produced in 1899?
3. How much of the wool you purchased was unwashed wool?
4. How many pounds of the wool you handle is nearly pure Merino?
5. How many pounds of the wool you buy is clipped before May 1st?
6. Is the percentage of the Merino wool you buy increasing or decreasing?
7. What is the most common fault with the preparation of the wool for the market?

A few points of interest should be noted from the above table.

First, That much more wool was purchased and reached the markets during the season of 1899 than was produced.

Second, Only about one-fifth of the wool marketed in Michigan was washed wool.

Third, Approximately one-fifth of the wool produced in Michigan is Merino or fine wool.

Fourth, Nearly one-fourth of the wool is clipped from Michigan flocks before May 1, showing that the practice of early shearing is much more common than formerly. A favorable condition which we are pleased to note.

It should be said, by way of explanation, that the totals opposite the different counties do not accurately represent the amount of wool produced in said counties. They mean that buyers in those counties purchased that amount of wool of the character indicated. The totals for the State can be relied upon, as well as the statements in regard to the condition of the wool marketed.

From reports sent in by local wool dealers it appears that only three counties in the State show an increase in the production of Merino wool, these counties being Emmet, Washtenaw and Eaton.

Six others, Midland, Mecosta, Iosco, Alpena, Barry and Clinton show neither an increase nor a decrease.

Thirty-three counties show a decided decrease in the amount of Merino wool produced. They are as follows: Arenac, Charlevoix, Grand Traverse, Osceola, Oscoda, Wexford, Allegan, Livingston, Macomb, Wayne, Gratiot, Huron, Isabella, Montcalm, Muskegon, Newaygo, Oceana, Monroe, Oakland, Ottawa, Shiawassee, St. Clair, St. Joseph, Van Buren, Saginaw, Sanilac, Tuscola, Berrien, Branch, Calhoun, Cass, Genesee and Hillsdale.

Three hundred and fifteen replies were received from local wool dealers. We made an effort to get answers to our inquiries from every wool buyer in Michigan. Only twelve out of the three hundred and fifteen were satisfied with the condition in which Michigan wool reaches the market. Eighteen made no criticisms. Fourteen complained that sheep were poorly cared for, hence wools were not of strong fibre. Fifty-six said wools reaching them were poorly tied, objecting to coarse, heavy wool twine, binder twine and sisal. A very large per cent found fault with the presence of tags, chaff, burrs, dirt and other litter in the fleeces. Tags and chaff were most often mentioned. A total of two hundred forty-nine buyers complained of dirty fleeces, including, as already said, tags, chaff and burrs.

With the vast amount of cheap unoccupied land in Michigan which is well adapted to sheep husbandry, combined with the present encouraging outlook for the wool and mutton industry, it is our opinion that farmers can well afford to double the number of sheep now kept in the State. Our climate and other conditions are favorable for the growth of wool and mutton, and our geographical position gives us many advantages both from a breeder's and from a general farmer's standpoint.

BREEDING FOR WOOL.

The present tendency of the wool market points to a continued active demand for fine grades of wool which the Merino alone produces. Michigan has long since proven her adaptability to the Merino. The Merino was brought to Michigan probably as early as 1828, and from that time until the beginning of the depression in the wool industry the Michigan Merino was well and favorably known all over the world. The successful breeding of Merino sheep is therefore assured; and if the adaptability of the Merino to Michigan's conditions is proven, and no one will deny it, then successful wool growing in Michigan cannot be questioned. We speak of the Merino, more particularly, in connection with the wool industry, because the Merino has always been recognized as the standard wool sheep of the world. The Merino has been bred and fed for the production of quantity and quality of fleece for generations.

A very large percentage of the wool produced in the United States is cross-bred wool. That is, of the wool reaching our markets, but a small percentage, relatively speaking, comes from pure-bred sheep, even if we take the total product from all the breeds of sheep having recognized registry associations into account.

The fleeces of wool which are graded by local dealers or commission men are seldom opened. The sorting process is a much closer and more accurate method of classifying wools. Before the wool is scoured it is generally sorted. The expert wool sorter opens

the fleece and removes a portion of it here and there and throws it into separate piles or baskets. The number of sorts of wool in fleeces varies greatly, ranging from two or three to five or six sorts from the same fleece. It has been found that fleeces from pure-bred sheep do not, as a rule, have as many sorts of wool in them as those taken from grade and cross-bred sheep.

Fleeces uniform in quality and length of staple are most desirable for manufacturing purposes. Consequently, if we wish to produce wools most desirable for the manufacturer, we must not cross indiscriminately. We can use for the foundation stock of a flock grade or native ewes, and by systematic grading up with some definite breed of sheep we can produce a more even grade of wool throughout the fleece.

MARKETING WOOL.

Unlike most other farm products, wool cannot be consumed on the farm. It is true that in the days of our grandmothers, and the spinning wheel, a large part of the then small wool product of the United States was manufactured and used upon the farm. Now all is changed. We neither spin the wool upon the farm, nor is it possible for us, when low prices prevail, to use up the surplus by feeding to our farm animals, thus converting it into meat products, as it is possible with grains and hay produced upon the farm.

The question of wool markets and the preparation of wool for the market is therefore one of vital importance to the wool grower.

PREPARATION OF WOOL FOR THE MARKET.

It is unfortunate that some of our wool growers think that there is little to be learned on this subject, while others consider it a matter of minor importance. On the other hand, we are glad to note that among the thoughtful, progressive sheep men throughout the State there is a general awakening along these lines and a willingness shown to aid in an attempt to place Michigan wool on a par with the wool of any other state or country—a position which her wool is entitled to hold.

As a wool grower, the writer has always wanted to find the real reasons why Michigan wools sell lower in the markets than those from the states of Ohio and Pennsylvania. All who have studied the markets carefully, know that Michigan wools sell for from three to five cents per pound less for the same grade of wool than those grown in Ohio and Pennsylvania. They also know that there is no grade for Michigan wool above X, or to put it in another way, all wools grading X or finer, are graded as X and above, instead of making two grades, X, XX and above, as the grades are made for Ohio and Pennsylvania wools.

Those who are acquainted with the wools grown in the different states assure us that while perhaps the quality of wool grading XX and above, is much greater in Ohio and Pennsylvania, yet there is a considerable quantity of our Michigan wool which does, in reality, grade XX and above. When it does possess the quality necessary to grade XX and above, it is not sold as Michigan wool, but as Ohio and Pennsylvania.

If Michigan wool growers do not produce enough wool of the XX and above grade to warrant dealers to add such a classification to our Michigan wool quotations in the market, perhaps we must rest content for a time, but one thing is certain, those who produce such wool from Michigan flocks should receive the Ohio and Pennsylvania quotations for such grades of wool instead of Michigan quotations for a grade of wool as low as X. The difference in price amounts to no inconsiderable sum in many instances.

That we might get some light on the subject of quotations of Michigan wools, we addressed a series of questions to several wool dealers in the United States whose opinions, as far as they go, ought to be valuable.

We give below the questions and answers:

Question No. 1.—It is a very noticeable fact that the Michigan wools are not quoted as high in the market as those from some other states. Why is this? Is it due to the fact of inferior quality or is it because it is not so well grown and prepared for the market?

Answer by No. 1.—In our opinion the reason for the difference between the market value of Michigan wool and that from other states, as Ohio, for instance, is due to several causes: the inferior quality of breeding sheep, the wool not being so well grown or cared for or prepared for the market, many farmers being negligent in permitting their sheep to feed in hay or straw stacks or from hay racks. The climate also interferes with the proper growth, and, in some measure, necessitates housing the sheep during the winter months and feeding them entirely upon grain, whereas, where the climate is propitious, they thrive better if allowed to graze on the farms.

Answers by Nos. 2, 3, 4 and 5.—Michigan wool is not so well grown nor is it so well packed as Ohio and Pennsylvania wools. The fleeces contain more vegetable matter, such as seeds and chaff, as well as a higher percentage of grease and tags. This makes the shrinkage greater and the grease value correspondingly less.

Answer by No. 6.—As all wools are sold on the basis of their scoured value, and as Michigan wools shrink heavier than those coming from Ohio, Indiana, Pennsylvania, Kentucky, etc., naturally, their grease price is lower. It is not on account of quality, but on account of condition. In other words, shrinkage of wool.

Answer by No. 7.—The reason Michigan wools are not quoted as high as Ohio and Pennsylvania is because, on the average, they are not as well bred, and the wool is heavier: the additional weight per fleece makes the compensation to the farmer equal to other states.

Answer by No. 8.—The value of all wool as marketed depends upon its intrinsic value, that is to say, the cost and quality of the scoured product when sorted and ready for manufacturing. The value of the scoured product is dependent upon first, staple; second, character: and third, quality. Michigan wools are not usually as uniform in grade, that is to say, as well bred nor as carefully put up as Ohio or Pennsylvania. The shrinkage is greater and therefore the market value is less.

Answer by No. 9.—One reason is, it is probably owing to the climate and feed that wools in the northern tier of states are not in all respects as good "working" wools as those grown further south; furthermore, the wools, as a rule, are prepared for the market in a less careful manner after being shorn.

Question No. 2.—What is the most common fault in the preparation of Michigan wools for the market?

Answers by Nos. 1, 2, 3, 4, 5, 7 and 9.—The most common fault in the preparation of Michigan wools for the market is that they contain seeds, tags stuffed inside the fleeces, and too much twine (mainly sisal), to which the manufacturers object strongly, as the sisal twine works into the goods.

Answer by No. 6.—We know of no general complaint as to the preparation of Michigan wools. They are in good favor and sell as well as any other stocks of equal condition.

Answer by No. 8.—As a rule Michigan wools are not as carefully washed as Ohio wools.

Question No. 3.—What per cent of the Michigan washed wools are graded as unmerchantable? What is your opinion in regard to the advisability of farmers continuing the process of washing sheep?

Answers by Nos. 1, 3, 5, 8 and 9.—In our opinion we think 10 to 12 per cent is about the amount of Michigan washed wools that are graded as unmerchantable. We are distinctly of the opinion that it is better for the farmers and for all concerned, to market the wool in an unwashed condition. Our experience of thirty years in handling Michigan wools has led us to this unalterable conclusion, and we believe that the sooner the farmers adopt this universal practice, the better off they will be.

Answer by No. 2.—We usually figure, in the purchase of washed wool, an extra cent per pound, to allow for wool not sufficiently well washed.

Answer by No. 6.—It depends entirely as to the washing of the wool. One lot might have thrown out only a very small percentage as unmerchantable wool, whereas another might all be classed as of that condition. We do not think it advisable to wash wools, the unwashed being in better favor and selling more freely.

Answer by No. 7.—We cannot give a reliable estimate of the percentage of unmerchantable, as that grade is only made out of the fine washed wool, and the last year or two there has been a decrease in the proportion of fine washed wools.

Question No. 4.—Is the practice as common as formerly? (Those who have tried it seem to favor shearing in April. If this is generally practiced washing sheep would be impossible. Would the argument against early shearing because of inability to wash sheep before shearing be a strong one?)

Answers by Nos. 1, 3, 6 and 9.—The practice of washing is not as common as formerly, which is probably due to the low value ruling during the free wool period and the fact that the farmers have found that it was distinctly to their advantage to market their wool unwashed.

Answers by Nos. 2, 4, 5, 7 and 8.—The principal argument against early shearing, it seems to us, would be in the fact that the staple would be shorter.* Ordinarily the Eastern wool market is a little higher in April than in June and July, and the early shorn wools command a better price in consequence. We are inclined to favor the practice of shearing unwashed, rather than washing.

Question No. 5.—On account of the prevalence of ticks, lice and scab in many sections of the United States, dipping has become almost a necessity. Do you find that certain dips are detrimental to the fleeces or do they in any way lessen their value? If so, what dips ought a farmer to avoid?

Answer by No. 1.—We have been considerably interested in the question of dips and have no hesitation in saying that a lime and sulphur dip is both injurious to the sheep as well as to the wool, although it is very effective in killing ticks, lice and scabs. In the extreme west, that is Wyoming, Montana and Idaho, where the larger flockmasters have made dipping a special study, they incline to some form of tobacco dip, believing that it is less injurious to both the sheep and the wool and nearly as effectual as the lime and sulphur.

Answer by No. 2.—Dipping has become almost universal. A great many of the dips used are harmful fór various reasons. Just exactly what dip to use we cannot say, but we know that there are some dips which hurt the wool and depreciate its value.

Answer by No. 3.—Avoid lime and sulphur.

Answer by No. 4.—Yes. All dips make the wool look dingy.

Answer by No. 6.—Some dips are very detrimental to the wool, setting their grease and making it impossible to scour them white. We, however, are not familiar enough with the different dips to recommend any particular class or kind.

Answer by No. 8.—We are not very familiar with sheep dips. We do not remember seeing any dipped wool that had not been injured in value by dipping.

Answers by Nos. 5 and 9.—Dipping of sheep is detrimental and depreciates the value of the wool more or less.

Question No. 6.—Can you conceive of a dip being so compounded that it would be an actual advantage to the growth and condition of the wool?

Answer by No. 1.—We cannot conceive of any dip being so compounded that it will be an actual advantage to the growth or the condition of the wool, except where the sheep are afflicted with ticks, lice, scab or some other skin disease.

Answer by No. 3.—Yes.

Answers by Nos. 4, 5, 6, 7 and 9.—No.

Question No. 7.—Is the use of inferior twine and too much of it common enough to make it advisable to explain to wool growers the best grades of twine to use, the amount to use, etc.?

Answer by No. 1.—The use of inferior twine, and too much of it, is certainly a great drawback to the marketing of Michigan wool, and under all circumstances should the use of sisal or binding twine be avoided, as manufacturers discriminate strongly against fleeces tied up in this manner, as the vegetable substance gets into the yarns and ruins them unless the wool is carbonized. The latter process takes the life out of the fiber and also weakens it, hence carbonized wool is only used in inferior fabrics. We think six to eight feet of twine, such as the sample herewith enclosed, is sufficient to tie the wool in such manner that the fleeces can be marketed in good shape.

Answer by No. 2.—It is advisable for the grower to use as little twine as possible, and such twine should be of the best grade. It should simply be wound round the fleeces once.

Answers by Nos. 3, 4, 5 and 9.—Yes.

Answer by No. 6.—A small, hard round twine should be used, tying up the fleeces once across each way, the same as you would tie up a box, not using any more twine

* The staple would be no shorter if sheep were shorn in April each year.

than is actually necessary. A thick fiber twine is very detrimental, and most especially that called sisal.

Answer by No. 7.—The use of inferior twine is a disadvantage.

Answer by No. 8.—The use of sisal twine is a very serious injury to wool, and causes such damage in certain kinds of manufacture that manufacturers are obliged to use foreign wools to escape the risk of damage to their goods. If your efforts can prevent the use of sisal twine throughout the State it will make one step towards popularizing Michigan wool.

Question No. 8.—Some have advocated that wool should not be tied up in a wool box but should simply be partially folded and rolled up. Do you think that wool so put up would reach the market in as good shape as wool put up in a wool box large enough so that the wool is not compressed enough to make it appear heavy?

Answer by No. 1.—The use of the box we think is detrimental, as it causes too great a density to the fleece, and hence in estimating the shrinkages manufacturers are liable to put their figures too high, which of course is to the disadvantage of the farmer. We think that if the fleeces were properly tied, as is the case in most sections of Ohio, they would reach the market in as good shape as wool put up in a wool box.

Answers by Nos. 2, 5, 6 and 8.—We do not believe it necessary or advisable to tie wool up in a wool box, but it should be simply folded and then tied with a light, strong twine. We think this method still better than by tying them up in a box. In fact, some dealers refuse to take wools so tied.

Answer by No. 3.—Tie it up so as to use the least twine.

Answer by No. 4.—No material difference.

Answer by No. 7.—The proper twine to use is hard, smooth hemp twine, tied around the fleeces once each way.

Answer by No. 9.—We think tying fleeces in a box is bad policy.

Question No. 9.—Could you suggest any method of tying up wool, not now generally practiced in the United States which would be advantageous for our wool growers to adopt?

Answer by No. 1.—The only method we could suggest in tying up fleeces properly is to carefully turn in the belly and roll up the fleece, wrapping the twine three ways. Our experience has taught us that, unless the wools are stuffed, very little of the fleece is lost in handling.

Answer by No. 2.—If the growers would tie up the wool by simply folding it, and then use strong twine round the fleeces once, it would, in our opinion, be as good as anything.

Answer by No. 3.—Abroad they do not tie up the wool as a rule.

Answer by No. 4.—No.

Answer by No. 5.—Australian way, with two small strings only.

Answers by Nos. 6 and 7.—The only correct method is to roll up the fleece and tie as stated above.

Answer by No. 9.—Fleeces should be tied sufficiently with fine, strong twine to hold them together, and that is all that is necessary.

Question No. 10.—Are the paint marks used quite generally by farmers to identify their sheep a source of much loss to the producer?

Answer by No. 1.—Paint marks are a detriment to the marketing of wool and hence should be avoided wherever possible, and we think this should be easy enough where wools are grown as they are in Michigan, fences separating different farmers' flocks.

Answer by No. 2.—If the growers could get some other means of identifying their sheep, other than paint, it would appreciate the value of wool, as the portion of wool covered by paint is practically worthless.

Answer by No. 4.—Not in Michigan.

Answer by No. 5.—They are in every way. It has to be all broken out and put into the low grade or strained sort.

Answer by No. 6.—Where the sheep are marked with paint or tar it has to be clipped out by the sorters before scouring and causes considerable expense and loss.

Answer by No. 7.—About paint marks, it is necessary for farmers to mark their sheep in some way, but under no condition should they use paint that has any mixture of tar, as it is absolutely impossible to extract the tar from the wool, even after it gets into goods.

Answer by No. 8.—Paint marks are a disadvantage in any wool, and for some classes of yarn the clips containing the paint marks cannot be used at all. It would be an advantage to the grower to clip off the paint marks before shearing the sheep.

Answer by No. 9.—Of late years we see no paint marks on sheep raised east of the Mississippi which are objectionable.

Question No. 11.—In shearing, a novice often makes second cuttings; could you give anything like an approximate estimate of the per cent of fleeces injured by improper shearing?

Answers by Nos. 1, 2, 6, 8 and 9.—It is impossible to give the percentage of fleeces injured by improper shearing.

Answers by Nos. 3 and 4.—No.

Answer by No. 5.—It (the short clips) is not worth much; cannot give estimate.

Answer by No. 7.—The second cuttings you speak of as an incident of green hands shearing is an infinitesimal amount.

Question No. 12.—In your judgment what grade or grades of wool are likely to return to the producer the best profits in the next few years?

Answer by No. 1.—It is almost impossible to definitely form an opinion as to the grades of wool which are likely to return to the producer the best profits in the next few years, as everything depends upon fashions in woolen goods, and no one can determine in what direction they will lean.

Answer by No. 2.—This is a difficult question to answer, as the grades used depend upon the fashion. Manufacturers make such goods as they can sell, and buy wools which are essential to the making of such goods.

Answer by No. 3.—Fine wool will profit the grower, but medium wool is more profitable.

Answer by No. 4.—Varies with each season's fashion.

Answer by No. 5.—If I knew I would buy all that kind.

Answer by No. 6.—The grades known as "1-4 and Medium" in our judgment are those most likely to be in demand and to command higher prices within the next year or two.

Answer by No. 7.—To your question as to our opinion as to the grade of wool that will pay the producer the next few years, we would say that the producer is the best judge of that, as the value of the mutton carcass enters largely into the profit of sheep industry.

Answer by No. 8.—In all wool growing sections of the world it has become apparent in recent years that wool could not be raised for the fleece alone with profit. In South America the breeding of mutton sheep has increased until now about 70 per cent of the clip which formerly was all Merino, is all English or cross-bred wool. Practically the whole of the New Zealand clip is from English or cross-bred sheep, and the increase of mutton sheep is growing in other parts of Australia. The duty may give the growers of Merino wools here for a while an opportunity to produce wool profitably, particularly in view of the decrease in the production of Australia and South America, but we think eventually it will be found that the wool grower will have to market the carcass as well as the fleece, and that mutton sheep, with a long stapled fleece, as fine as possible, will prove the most profitable to raise, say from 1-2 to 3-8 grade.

Answer by No. 9.—Impossible for us to give an opinion.

Answer by No. 10.—In a general way Michigan wool is undesirable because, partly from carelessness and partly from intent, the wool is not carefully bred, is not properly skirted, is tied with the heaviest and worst twine possible, and is very apt to be filled with chaff and seed. The paint you speak of is a decided objection, but is not a peculiarity of Michigan, but pertains to most wools.

Washing the sheep, unless done much more carefully that has ever been done in your State, is a half-way measure at best, and for that reason we think it would be wiser to have it all marketed unwashed.

The box method of packing is undesirable. The fleece, after being properly freed from tags, bad skirts, and undesirable matter of all kinds, should be lightly folded and tied with as light twine and as little of it as is possible. In our judgment the amount of twine used should not cover one-fifth or one-tenth part of what is commonly used. Sisal twine should be absolutely prohibited. It actually injures the value of the whole fleece.

The following firms are the ones who were kind enough to answer the above questions. For convenience we have designated their answers by number:

No. 1. Fenno Brothers & Childs, 562 Atlantic ave., Boston, Mass.
No. 2. Hecht, Liebmann & Co., 211-217 Federal st., Boston, Mass.
No. 3. Jeremiah Williams & Co., 105 Federal st., Boston, Mass.
No. 4. Hallowell, Donald & Co., 556 Atlantic ave., Boston, Mass.
No. 5. East Weymouth Scouring Mill, East Weymouth, Mass.

No. 6. Chas. J. Webb & Co., 116 Chestnut st., Philadelphia, Pa.
No. 7. Louis S. Fiske & Co., 34 So. Front st. and 35 Letitia st., Philadelphia, Pa.
No. 8. Manger & Avery, 564 Atlantic ave., Boston, Mass.
No. 9. Denny, Rice & Co., 606 to 610 Atlantic ave., Boston, Mass.
No. 10. Whitman, Farnsworth & Thayer, 118 Federal st., Boston, Mass.

While there seems to be some difference of opinion in regard to minor points, and while the writer could not, in all instances, agree to some statements made,—it will be noticed that there is a general uniformity of opinion that Michigan wools might be,— (1) Better grown and (2) More carefully prepared for the market.

The sooner we, as wool growers, fully appreciate the difference in value to the manufacturer of wools well grown and poorly grown, the sooner will all our wools command a better price.

We must banish forever the idea that condition, quantity, quality and length of staple are all of the important factors affecting its value. But we must give more attention to the growing of wool fibers of great strength. Strength of the wool fiber depends, to a considerable extent, upon the quality of wool or the size of the fibers. The important point, however, in this connection, which we wish to emphasize at this time, is that there is a great difference in the relative strength of fibers of the same quality or grade of wool. When a difference of this kind exists it is largely due to the way it has been grown.

The strongest fiber of wool is produced on sheep when the animal has been supplied with an abundance of nourishing food, at all times throughout the year.

If, on the contrary, a sheep is poorly nourished, the strength of the wool fiber will sooner or later be seriously affected. If proper care is not continuous throughout the year, and the flock is neglected during some particular period, then a break in the fiber occurs, which greatly weakens the fiber at that particular point. The strength of the weakest place in the fiber decides the strength of the whole fiber.

So far as the writer has been able to discover there is no special ration, which, if fed to sheep, will produce wool of great strength, nor can we, at any time, say that any special ration is to be recommended to produce a large quantity of wool. It has often been observed that sheep and lambs that have been on full feed for long periods shear heavy fleeces of wool. This would indicate that any ration calculated to keep the sheep in a thrifty condition would be a suitable one for growing large quantities of wool.

From what we have said above, the wool grower will understand that it is highly desirable to provide the sheep proper nourishment throughout the year, permitting no periods of neglect to intervene to destroy the strength of the fibers of the fleece. Liberal and judicious feeding does not change the quality of the wool, but it does affect the strength and the quantity of the wool produced by a given sheep.

The weight of wool produced is affected both by increasing the length of fiber and by increasing the amount of yolk and natural oil in the fleece.

MANAGEMENT OF THE FLOCK IN ITS RELATION TO CONDITION OF WOOL.

The condition of the wool refers to the cleanliness of the fleece,—the absence of all foreign substances, such as sand, burrs, chaff and all other substances looked upon by the wool manufacturer as litter.

It is not because these naturally light substances affect the weight of the fleece to any considerable extent, that the wool manufacturers so strenuously object to their presence in the fleece, but that they must be removed from the fleece before it is ready for manufacturing purposes and the process of separating these substances from the fleece is not only very tedious but very expensive, and that, as a rule, it cannot be done without more or less injury to the wool fiber. Knowing the above facts, we can easily see how condition affects the price of wool, because it directly affects its value.

It is not a difficult matter for the wool grower to so manage his flocks that the wool produced by them will be practically free from all litter. He must provide racks for the sheep which will permit them to eat without getting their necks full of chaff, seeds and dust. (It is, of course, unnecessary to mention the old straw stack.) He must keep his farm free from burr-bearing weeds, his flock will keep most other weeds in check. If we needed any proof that the farmers of our country are negligent about allowing weeds to grow and seed in abundance on their farms, we could visit some large wool scouring or woolen mill and carefully examine the refuse or waste from the

mills, and we would have abundant proof in the millions of weed seeds found. At some mills where such refuse is dumped where seeds can germinate and grow, we find a large number of species and varieties of weeds.

UNIFORM PRICES FOR MIXED LOTS OF WOOL.

Another factor in the marketing of wool by growers is that many insist on getting a uniform price for their wool, even though they may produce several grades of wool differing much in their value to the manufacturer. Suppose the local dealer tries to purchase this wool upon a basis of its value, he must then pay different prices per pound after he has made an approximate estimate of the amount of the different grades of wool in the lot. If the producer insists on getting a uniform price for the entire clip, the dealer must determine what a safe average price would be. You may think that this makes little or no difference to the producer. We believe it makes a very material difference; first, because the dealer is pretty sure to strike under rather than over the exact average price he could afford to pay to be sure to save himself; second, since this is a general practice in Michigan, the grower seldom has an opportunity to learn which are the most valuable fleeces, and why. There is, consequently, little chance or hope for improvement so long as this state of affairs continues. Local dealers have more opportunity for learning the details of the wool business and we think would be willing to impart information to producers of wool if said producers would manifest a desire to learn and improve their methods in growing and handling their wools.

Your local dealer, if he buys wool on its merits and pays what your wool is worth, should have the privilege of handling your wool. "Commission buyers" are always ready to pay a uniform price for your wool, because they are paid so much per pound for buying wool, but rest assured when they pay a uniform price they are keeping within a safe average price limit. Wool growers need to become more familiar with the trade. It is unfortunate that many Michigan sheep owners, who keep small flocks, must compete with other sections of the country where large flocks are kept, producing a large amount of wool of a uniform grade. These large clips of a uniform grade are more sought after by manufacturers than many small clips that are apt to vary more or less. This suggests the desirability of Michigan wool growers making an attempt to produce a uniform grade of wool in some sections of the State. Buyers and manufacturers desiring the grade of wool produced will soon learn where they can pick up a large amount of wool suitable for their particular purpose. The grade of wool produced is not so material as that it be uniform.

That we might get more definite information concerning the wool produced by the various breeds of sheep, more or less common in the United States, we tried to secure a ewe's and a ram's fleece of each of the breeds, which should be an average typical fleece of the breed. In most cases we were successful in securing what we desired, but in other instances we were not fully satisfied that the fleeces submitted were typical of the breed.

In examining the tabulated facts below we make the request that the reader should not consider the figures there exhibited as settling the relative merits of the various breeds as wool producers. Certain general conclusions may be drawn from the table, but it must be obvious to every thoughtful reader that it would be very nearly impossible to secure two fleeces which would in every way be representative of the various breeds.

Table showing Weight of Fleece, Per Cent of Shrink, Commercial Grade and Price per Pound of Fleeces from different breeds of Sheep.

Breed.	Sex.	Age, years.	Weight of fleece in grease.	Weight of fleece after scouring.	Per cent of shrink.	Commercial grade.	**Price per pound in grease before scouring	**Price per pound after scouring.
16 American Merino	Ewe	3	17lb 12 oz.	4lb 11½ oz	72.36	X Clothing	$0.14	$0.50
17 American Merino	Ram	4	26 12½	6 10½	75.15	XX Clothing	.13	.52
27 National Delaine Merino	Ewe	4	9 10	4 1	57.79	Fine Delaine	.21½	.51
39 Improved Black Top Merino	Ram	1	18 11¾	5 11	69.64	Fine Delaine	.20	.66¼
30 American Rambouillet	Ewe	2	8 1¾	3 9¾	55.42	X Clothing	.20	.44½
31 American Rambouillet	Ram	1	7 15	4 9½	44.19	Fine Delaine	.22	.39¼
25 *Cross Bred	Ewe	1	11 1	4 5½	60.73	¼ Clothing	.19	.48¼
35 Southdown	Ram	1	7 5½	3 4	55.75	⅜ Combing	.22	.50
36 Southdown	Ewe	1	7 1	3 8½	50.00	⅜ Combing	.23	.46
38 Southdown	Ewe	3	7 12	4 11½	39.11	⅜ Combing	.23	.37¼
24 Shropshire	Ewe	1	10 12	5 9	48.25	¼ Combing	.22	.42¼
26 Suffolk	Ram	1	6 15½	3	56.95	Low ⅜ Combing	.23	.53½
29 Hampshire	Ewe	3	9 6	5 4½	43.67	⅜ Combing	.23	.41
18 Oxford Down	Ewe	3	12 9	7 13½	37.56	Braid Combing	.20	.32¼
23 Oxford Down	Ewe	3	15 2	8 13½	41.53	¼ Combing	.19	.32¼
42 Leicester	Ram	‡10	12 8½	8 5¾	33.33	Low ¼ Blood	.19	.28¼
32 Cotswold	Ram	2	15 3	9 13	35.39	Coarse Combing	.19	.29¼
33 Cotswold	Ewe	1	12 3½	7 12	36.57	Braid Combing	.19	.30¼
34 Lincoln	Ram	‡11	14 8¾	10 4¾	33.77	Braid Combing	.20	.30¼
34 Lincoln	Ewe	1	14 11	10 2½	30.85	Braid Combing	.20	.29
43 Tunis	Ewe	‡11	8 12¾	4 5	43.75	⅜ Combing	.22½	.39¼
19 Dorset Horn	Ewe	2	6 12½	4 1	40.09	⅜ Combing	.22½	.37
20 Dorset Horn	Ram	1	8 2½	4 4½	47.51	¼ Combing	.22	.42¼
37 Dorset Horn	Ewe	2	8 15	4 10½	47.90	⅜ Combing	.22	.42¼
41 Dorset Horn	Ram	‡13	9 1½	4 14½	46.04	¼ Combing	.22	.40¼
28 Cheviot	Ewe	2	9 2	6 10	27.39	¼ Combing	.22½	.31
21 †Cross Bred	Ewe	1	7 4	4 4	41.38	⅜ Combing	.21½	.34

* Hampshire and Cotswold.
† Rambouillet and American Merino.
‡ Months old.
** Prices quoted Aug. 31, 1899.

That there might be absolute fairness in securing representative fleeces of each breed, the writer appealed to the secretaries of the various sheep breeders' and registry associations to aid in securing the fleeces. In most instances much valuable assistance was rendered.

The weight of all fleeces is computed upon the basis of 365 days' growth.

Fleeces number 16 to 27, inclusive, were furnished by the Michigan Agricultural College.

The remaining fleeces were furnished by the following well known breeders:

28. H. H. Keim, Ladoga, Ind.
29. W. C. Smith, Washington, Mich.
30. L. B. Townsend Estate, Ionia, Mich.
31. L. B. Townsend Estate, Ionia, Mich.
32. George Harding & Son, Waukesha, Wis.
33. George Harding & Son, Waukesha, Wis.
34. Robert Knight & Son, Marlette, Mich.
35. Jerome Leeland, Springfield, Ill.
36. Jerome Leeland, Springfield, Ill.
37. George C. Woodman, Manistee, Mich.
38. Mrs. Virginia C. Meredith, Cambridge City, Ind.
39. L. L. Harsh, Union City, Mich.
40. J. J. England, Caro, Mich.
41. George C. Woodman, Manistee, Mich.
42. John Marshall, Cass City, Mich.
43. Chas. Roundtree, Youngsville, Ind.

We are indebted to E. Frank Lewis, Lawrence, Mass., for scouring the above fleeces and giving us the data.

For the benefit of those who may not understand fully what is meant by the terms used in the column headed "Commercial Grade," we will make a few brief explanations.

All domestic wools may be classified according to their quality, strength, and length of staple as (1) Clothing or carding wools; (2) Combing wools; (3) Delaine wools.

Clothing wools are short wools and incidentally of relatively fine quality. In a general way all wools less than two and one-half inches in length are clothing or carding wools.

Combing wools are both long in staple and strong. Most of the coarser long wools are graded as combing wools. However, when a wool is long enough for combing and has the necessary size of fiber it may still be disqualified as a combing wool if it has been poorly grown. Breaks in the fiber caused by insufficient nourishment destroy the value of wools for combing purposes.

Delaine wools are fine wools clipped from all varieties of Merinos or high grade Merinos which grow wool of long, strong staple. We might say that Delaine wools are combing fine wools.

Each one of the three classes of wools above mentioned are subdivided according to quality or size of fiber, as follows:

Clothing wools.	Picklock XXX XX X No. 1 or ½ blood No. 2 or ⅜ blood No. 3 or ¼ blood
Combing wools.	⅜ blood ¼ blood Coarse or common Braid
Delaine wools. .	Fine Medium Low

Picklock is a grade that is rarely found in the markets at the present time. Formerly there was quite a large quantity of this wool reaching our markets. The wool from pure Saxony Merino sheep usually grades Picklock. XXX is also hard to find. When the Saxony Merino was crossed with the common American or Spanish Merino the cross-bred resulting usually produced wool grading XXX.

XX is considered the standard for a pure bred Merino.

Some three-quarter blood Merino, nearly all of the high grade Merino and much of the coarser pure blood Merino wools, grade as X.

The terms 1-2, 3-8 and 1-4 blood do not necessarily mean that the wools were grown on sheep possessing just that fraction of Merino blood. Many sheep containing no Merino blood grow wool grading 3-8 and 1-4 blood. No. 1 or ½ blood is the next coarser grade than X. No. 2 is coarser than No. 1, and so on.

Coarse and Braid wools are invariably combing wools and are the grades most frequently produced by Lincolns, Leicesters and Cotswolds, which have fleeces coarse and long in staple but bright and lustrous.

Fine Delaine wool is Merino wool fine enough to grade X or above and long in staple.

Medium Delaine is the grade next coarser than the above, while Low Delaine is long enough to be Combing, but a grade finer than the finest Combing wools, namely, 3-8 blood.

Other grades of wool which are occasionally quoted in the markets are felting wools and noils.

By our request Mr. Charles F. Avery, of Boston, defined felting wools and noils as follows:

"Felting wools are wools which are adapted for felting purposes, usually of short staple, and having properties which cause them to felt quickly. We presume that you understand that felting is a process whereby the fibers are interlocked in such a way that a solid fabric is produced without the intermediate process of spinning and weaving.

Noils.—In the process of combing wool the fibers are drawn between fine needles and the dead and tender wools are broken off in the process and produce what are called Noils, or what might be called Combing Waste. The long and healthy fibers are carried along through the combing process and are formed into what are called Worsted Tops."

WASHING SHEEP.

As has been stated elsewhere in this Bulletin, washing sheep is not nearly so prevalent as formerly. Most manufacturers agree that wool which has been washed in the country is not as desirable as that which has been sent to market unwashed. It is an unsatisfactory process at best, and many times the country washing makes scouring at the mills more difficult.

SHEARING AND WASHING.

After a careful investigation of the subject we are convinced that, in the long run, it is more profitable to dispense with washing altogether.

We have secured better results by shearing our sheep during the first half of April than later in the season. This, of course, makes it impossible to wash sheep before shearing. We are satisfied that we can get, not only a heavier average fleece, but also a wool of better strength from the same flock by shearing during the first half of April than by shearing in May or June.

If reasonable care is taken to keep the wool free from dirt and litter while on the sheep's back then there is little to be gained by washing. By an examination of the wool market quotations we note a class of unmerchantable wools. This class includes wools poorly washed. A large per cent of our Michigan washed wools are sold as unmerchantable, at a price about equal to that of unwashed wools.

We should not leave this subject of washing without saying that if we could think the washing process an advantage to grower and consumer alike we would still think the custom of doubtful utility on account of injury to the sheep. Sheep are often roughly handled and not infrequently we believe more injury is done to the sheep than good to the fleece. The sheep will suffer no inconvenience from early shearing except for the first few days, if they are properly sheltered and protected from the cold, and more especially storms. The wool makes a rapid growth during the cool months of spring and the sheep is not sweltering under a thick blanket of wool. In the latter case the sheep is not only uncomfortable, but the wool makes but little if any growth.

For several years, in a majority of instances, the Eastern wool markets have been better in April than in June. This would give the grower, who makes a practice of early spring shearing, a slight advantage as to markets.

SHEARING SHEEP.

The best job of shearing is that which secures the largest amount of wool in the best condition for market without injury to the sheep. It is highly desirable that the sheep be closely shorn and that there should be no second cuts. The fleece should be kept intact, not torn apart, and the skin of the sheep should not be wounded.

Nearly all of the sheep east of the Mississippi river are shorn by hand, while many in the west and on the ranges are shorn by machines.

Thinking that many of our readers would be interested in the practical workings of the shearing machine for small flocks we addressed several questions to men who have used the shearing machines and are competent to speak of the advisability of their general adoption on Michigan farms. We are indebted to the following gentlemen for replies:

1. John MacQueen, Kirkland, Ill.: 2. J. E. Wing, Mechanicsburg, Ohio, and 3. Coffland & Lybrand, Richland Center, Wis.

The questions and answers follow:

1st. Would you advise a man owning fifty to one hundred sheep to have anything to do with any make of shearing machine?

Answer by No. 1.—I would not advise anyone to buy a machine for fifty or one hundred sheep.

Answer by No. 2.—Wait. Some day they will be practical.

Answer by No. 3.—We would not advise a man owning fifty to one hundred sheep to purchase a sheep shearing machine for these reasons: The expense is greater than with shears, two men not being able to shear more than one man can with shears. They are almost continually out of repair. Knives are very easy to dull, and in order to sharpen them have to be forwarded to the factory.

2d. What are the advantages to be gained by using a sheep shearing machine?

Answer by No. 1.—The advantages of using a sheep shearing machine are that one gets from three-quarters to one pound of wool more from each sheep and leaves them nice and smooth, fit to put on the market in one-half the time hand sheared sheep are. Also, that one can get inexperienced men to run machines when practical men cannot be found, which is often the case.

Answer by No. 2.—They do far better work. Don't cut the sheep. Take off the wool smoothly.

Answer by No. 3.—The advantages to be gained are that they leave the carcass in nice even shape and do very little cutting. The fleece is also in good shape, no double cutting to speak of.

3d. What are the disadvantages?

Answer by No. 1.—There are no disadvantages in using sheep shearing machines—in fact, I would not be without them for twice their cost.

Answer by No. 2.—Leave the sheep exposed to flies. Also they get dull and you cannot sharpen the knives, must send to factory.

Answer by No. 3.—The disadvantages are as described above.

Another party, who did not care to have his name used, stated that, in his experience, he had found that he could get from one-half to nearly a pound more wool per sheep with machine shearing than with hand shearing. "It depends considerably upon the kind of sheep you are shearing. With the heavier pelted and wrinkled sheep we can take off considerably more than with the coarse wooled. This extra wool would about pay for the shearing in ordinary cases. There are no disadvantages in using the machines. It helps the appearance of the sheep, and, in my experience, I have found nothing detrimental in their use. It is only a matter of the machine's being used properly by the operator. Should it not be properly handled the chances are that the wool would be cut twice, the same as it is in hand shearing."

We submit a cut below which exihibits a remarkable good job of hand shearing. The wool is closely clipped, leaving a smooth, even surface.

TYING UP OR PACKING WOOL.

It will be observed that, almost without exception, commission men and wool dealers agree that one of the greatest faults, if not the greatest fault, of Michigan wools, lies in the way they are tied or prepared for the market. To sum up the objections they would be something as follows:

1. Either by neglect or intent, tags and litter are often incorporated in the fleeces.
2. Too much twine of an inferior grade is used.
3. The use of the wool box, which packs the fleeces into a square bundle that is too compact.

Let us consider these objections. If we understand tags to refer to bunches or locks of manure which have accumulated on small bits of wool about the thighs and hocks, then we should say by all means they should be left out of the fleece, and either sold separately, as tags, for what they will bring, or used as manure. We have known breeders of fine wool sheep who have thoroughly washed and dried the tags and then put a handful or so in each fleece. There is no great objection to this, providing the tags are well washed and thoroughly dry. We believe, however, that it would be more businesslike to sell the washed tags separately, as the wool will never be as valuable

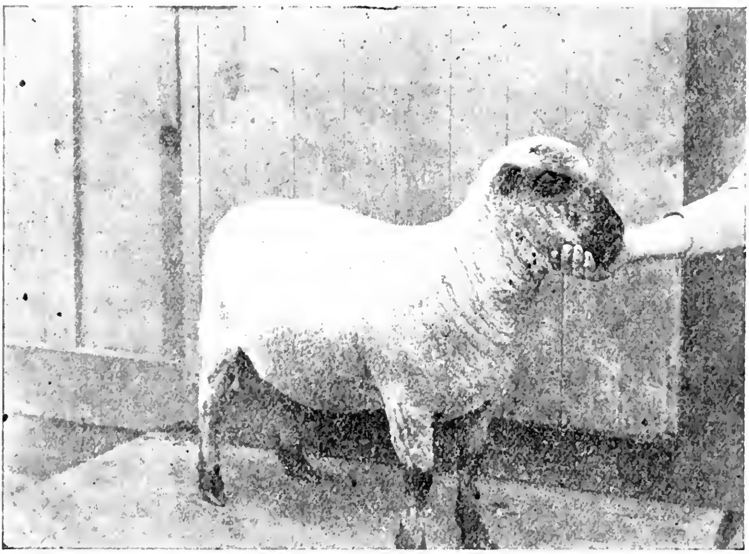


FIGURE No. 1.

as the rest of the fleece. We believe it perfectly legitimate to tie up all the wool that grows on the sheep in the fleece, provided that the wool is free from all foreign substances which would add to the natural weight of the fleece.

May we venture here to offer one reason why a majority of wool growers incorporate tags and litter in the fleeces which they sell? There are two distinct classes of growers who put tags into the fleece. The first class includes growers who put tags into the fleece either through absolute carelessness or with the evident intent of deceiving the buyer. For such we have no sympathy and we have reason to believe this class of men small. The second class includes growers who are progressive and business like. This statement sounds inconsistent, but it is not. These men have cut out tags and litter very carefully, it may be for two or three years; they have observed that, as a rule, they get no more for their wool than the men who put tags and all into their fleeces. This suggests that buyers are not careful enough in recognizing careful, painstaking methods on the part of the progressive growers. Buyers know the extra value of clean wool. Let them encourage the honest, painstaking growers in a substantial manner by giving

more per pound for their wool, a thing which they can well afford to do. Let them, at the same time, discrimnate against wool carelessly tied, or that contains chaff, burrs and other litter. Until buyers rigidly adhere to the above policy there can be but little improvement expected among wool growers.

The second and third objections are so closely associated that it is difficult to separate the two in a discussion of them. If the reader has carefully read the foregoing pages he will have a very definite idea in regard to the way the local dealers, commission men and manufacturers consider the present methods of Michigan growers in tying up their wool.

That we might get at the question from the growers' standpoint as well as the dealers' we addressed the following question to a number of prominent wool growers: **Is there anything any better than a good, large wool box in which to tie up fleeces in preparing them for market?** "No. We do not think any way of tying adds much if the fleece is kept entire and clean. It can be tied on the floor with one string." "Our buyers object to the wool box and we roll up the wool and use as little twine as possible."

The above answers are characteristic of all received.

We made a careful canvass of the State and found that a great majority of the wool growers use large twine, using to aid in the process of tying a square wool box.

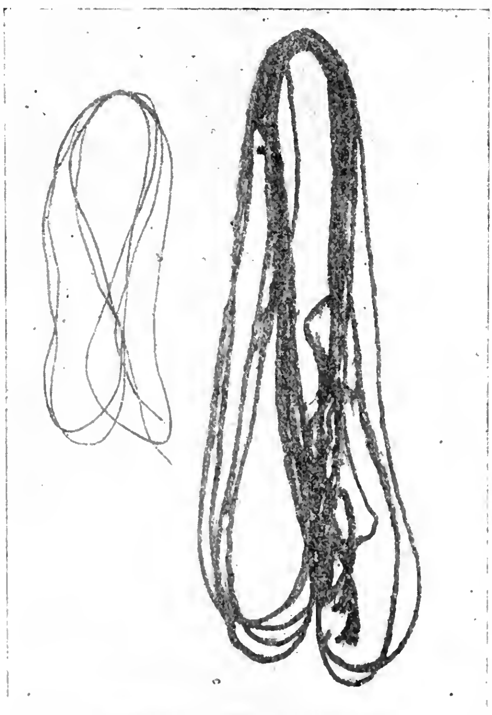


FIGURE No. 2.

We have consulted no less than a dozen of the leading Boston wool buyers and every one is prejudiced against wool tied with the common coarse twine, and radically so when tied with sisal twine. The most of our Michigan wools reach the manufacturer through Boston commission houses, and if they object to the twine we use, and pay less for our wool on account of it, it is time for us to make a change. The eastern wool houses do not object to coarse twine without reason. In the first place it is not business for wool growers to tie up a fleece with a coarse, heavy twine, when a small twine will do as well. It is not right to attempt to sell a lot of twine at from fifteen to twenty-five cents per pound which only cost five or six cents per pound. We give below a cut which illustrates very nicely the point we are trying to make.

The long coarse twine at the right was taken from a nine-pound Shropshire fleece done up in the ordinary way in a square wool box.

Fig. No. 3 shows a photograph of the fleece. The twine measured just twenty-four feet. The small short twine shows the amount of twine necessary to tie the same fleece by folding without any box and putting one string round each way.

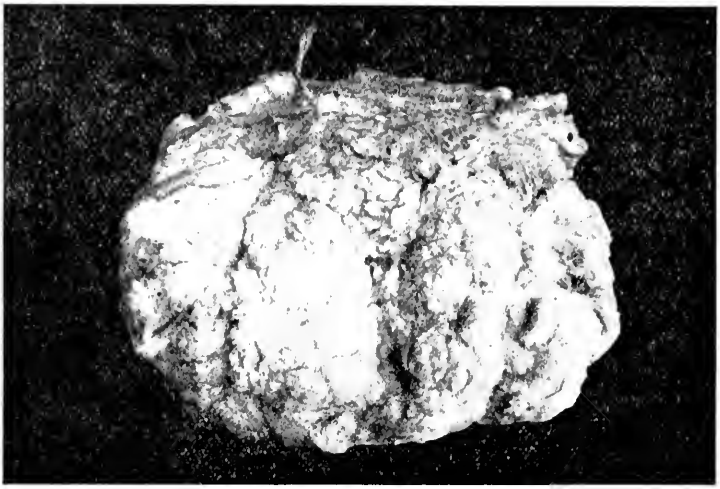


FIGURE NO. 3.

Fig. No. 4 shows the fleece tied with the fine twine or string once around each way. Fig. No. 5 represents an eighteen-pound Oxford fleece tied in a square wool box and Fig. 6 a twelve-pound Delaine Merino fleece tied in the same way. Besides weight there is still another reason why buyers object to coarse twine. The coarse, hard fibers

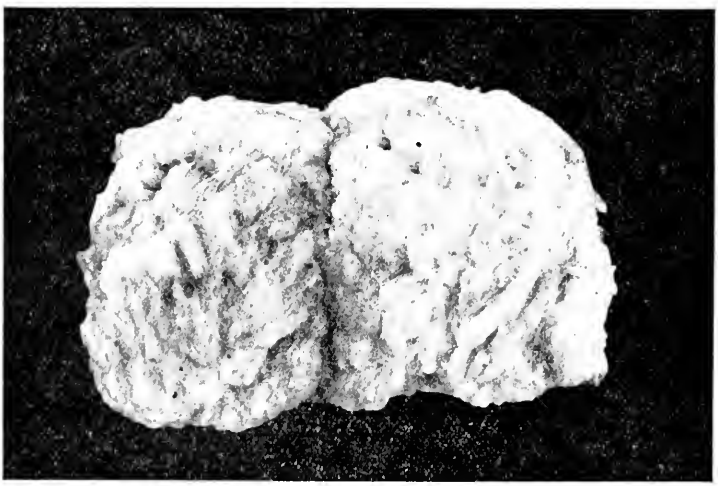


FIGURE NO. 4.

of the twine are apt to work in among the wool fibers. Manufacturers find it difficult to separate these foreign fibers from the wool, and unless they are removed they work injury to goods manufactured from such wool. We believe the time has come when Michigan wool growers should adopt a small twine of better quality.

FIGURE No. 5.

FIGURE No. 6.

A small linen twine used by nearly all wool growers in Australia is to be recommended in every way. While such twine costs about twenty-five cents per pound it runs nearly two thousand seven hundred feet to the pound. A pound of linen twine should therefore tie two hundred and seventy fleeces, allowing ten feet to each fleece, or one hundred thirty-five fleeces, allowing twenty feet to each fleece. This linen twine is a soft twine and should the fibers become mixed with the wool fibers there would be no injury done. Number 18 hemp twine is also to be recommended. There are about six-

teen hundred feet of this twine to the pound and it can be purchased for about ten cents per pound. The only objection raised to the use of a small fine twine for tying wool was that it was hard on the wool packers' hands.

We can see how many growers would need to change their wool boxes to hold the ends of the twine. However, we do not hesitate to say that if Michigan farmers would generally adopt a small hemp or linen twine, this alone would go far towards placing Michigan wool on a par with Ohio and Pennsylvania wools.

A Merino fleece cannot be properly tied with one string each way. We can see no objection to using two or even three strings each way if it seems necessary to keep the fleece intact until it reaches the wool merchant or manufacturer. The great weight and character of the Merino fleece makes more twine necessary than with the more open wooled breeds of sheep. In our opinion two strings each way are sufficient. If the fleeces were not to be handled much, one each way would be ample.

The majority of the wool boxes, which tie the fleeces in a square bundle, are too small. The most of them were made for fleeces from Merino sheep and new ones have not been made for handling more bulky, coarse wool, consequently, the fleeces are packed too snugly together. This gives them a heavy, soggy appearance, when they should present a light, loose and bulky appearance.

The method of tying wool in Canada is quite satisfactory. The fleece is spread out on a clean shearing floor with the outer ends of the wool up. The skirts of the fleece are folded in towards the center, only a trifle at each end, but considerably on the sides, so that the sides lap well, then the fleece is rolled from end to end, making a short, cylindrical roll of wool. A small hemp twine is then run snugly around the roll a little distance from each end.

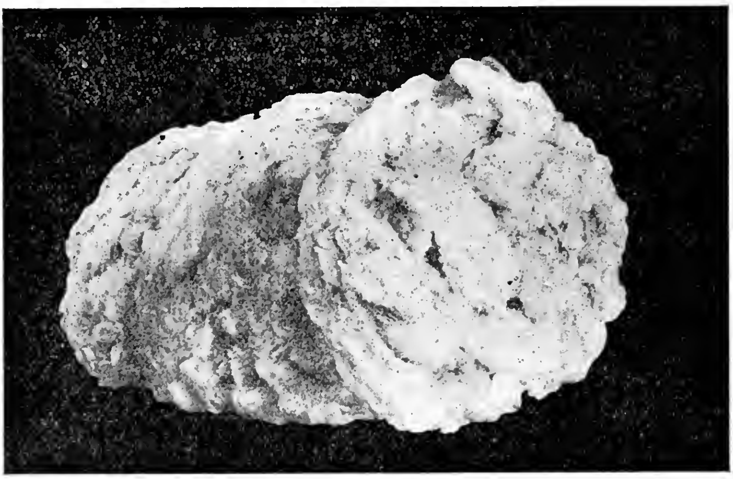


FIGURE No. 7.

Fig. No. 7 shows a nine-pound Shropshire fleece tied in this manner. Seven feet of twine was used in tying the fleece. It is said that a good lively man, who is accustomed to tying wool in this manner, will tie after eight or ten shearers.

Fig. No. 8 shows a fleece tied up after the manner in which some Englishmen tie their fleeces. No twine is used, but simply a roll of wool. This method is in no way to be recommended. It is not economical of time and does not leave the fleece in good condition, as it binds it too closely in some places, while it leaves the fleece in the best possible condition to get torn.

Before leaving this subject we wish to speak of a wool box which is quite generally used in some parts of Ohio. When the fleece is tied it does not have the heavy appearance that is so characteristic of the square box made fleece. It is sometimes spoken of as the round box or table, owing to the appearance of the fleece when ready for the

market. The sides of the table or box fold up similar to the old style box, but in the center a broad leather strap is so arranged that when brought over the fleece it rolls it into a compact bundle.

We consider ourselves very fortunate in being able to give our readers the benefit of the following letter from J. B. Jones, Montpelier, Ohio.

"With a desire to correct errors in wool handling, I hand you part of a Boston letter of the 14th inst."

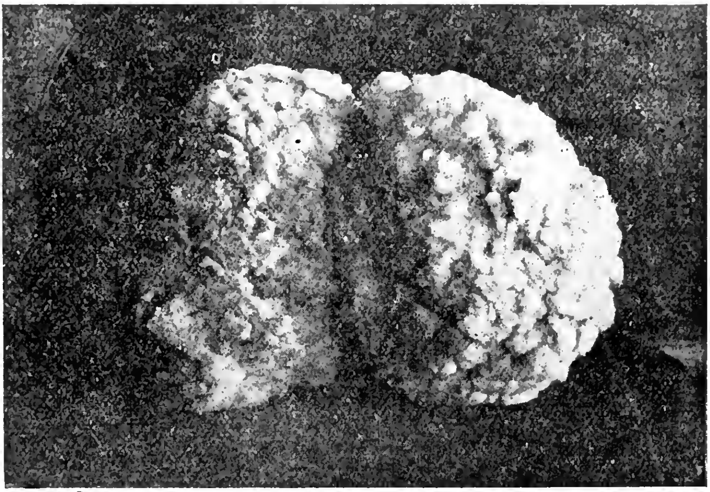


FIGURE NO. 8.

The following is an extract of the letter referred to. It is from one of the leading wool commission houses in Boston:

" 'We finished grading your wool last week and find it to be a very good lot, running largely to 1-2 and 3-8 unwashed, good stapled and bright colored. We shall certainly do our best to realize for you extreme outside prices for this wool, but regret to say that we cannot sell it for Ohio, as most of it has been put up in boxes, and, as you well know, these box fleeces are one of the characteristics of Michigan wool. We think it would be well for you to notify farmers in your neighborhood not to use the box when tying up their fleeces, but wrap them up lightly and put two or three twines around them. This is sufficient to hold them and the fleeces handle much lighter and look very much more like Western Reserve, Ohio wools.'

"Of five thousand six hundred pounds of washed wool shipped from Camden, Mich., this year, eight grades were made. The extremes in value ten cents per pound. Of twenty-eight thousand pounds unwashed, ten grades: extremes in value, nine cents per pound; these grades, exclusive of tags, sold outside of fleeces. They put the X and above washed at five cents per pound below same grade of Ohio—though part of it was bought in Ohio and all of it equal in quality to average Ohio, in my judgment, based on forty years of wool shipping, mostly from Ohio. That Michigan wool sells below its real value because of improper and dishonest preparation is well known among dealers. It ought not to be so, now that grades are greatly improved and many producers are seeking for best methods of handling. But too many continue to tie in a square box with five to seven strings each way, or three to four ounces of twine to the fleece, so tight that it handles more like a cheese than a fleece of wool, and no man can know what is inside until the string is cut, revealing often unwashed tags in a washed fleece and one to two pounds of tags containing two ounces of wool, clipping of hoofs, lambs' tails, etc., in unwashed fleeces: it will require time to remove the prejudice against Michigan wool. If growers will conform to the demands of the market, adopt the round box with one ounce of twine to the fleece, throw their tags on the compost heap, or sell for what they will bring, in a few years Michigan wool will be in demand at much better prices.

"I bought nine hundred pounds of well washed Delaine wool in Hillsdale county, round tied, no excess twine, paying twenty-eight cents per pound, which graded right up to Ohio at thirty-three cents in Boston, netting three cents per pound profit, while losing money on wool bought at twenty-three to twenty-four cents. Quality and condition generally observed is what Michigan needs."

In closing, permit me to say that because Michigan wools are not the best, we must not get the idea that they are the only wools which can be better grown or better prepared for the market. Other states are suffering from market prejudices which have been established by careless methods. Nor should we, knowing this, be any the less persistent in our efforts to place Michigan wool on a footing second to none in the open market.

SUGAR BEET INVESTIGATIONS.

BY J. D. TOWAR.

Bulletin 179.—Agricultural Department.

SUMMARY.

Sub-soil plowing practiced immediately before sowing the beets, owing perhaps to the severe drouth which followed, resulted in the complete loss of the crop.

Coarse manure applied some two months before sowing the beets resulted in increased yield and beets of a normal percentage of sugar.

Carefully prepared home mixed fertilizer gave higher yields and better beets than stable manure.

Nitrate of soda alone gave no marked increase in yield, but in combination with other elements generally increased the yield with a normal per cent of sugar.

In every case, nitrate of soda gave higher yields than sulphate of ammonia.

Wood ashes and salt increased the yield of beets slightly.

One ton of air slaked lime per acre increased slightly the yield of beets on the uplands without affecting the percentage of sugar.

On muck land one ton of air slaked lime per acre, in combination with other fertilizers, decreased the tonnage eleven per cent, and reduced the sugar content from 9.64 to 7.68 per cent. When lime was applied alone on muck land, increased applications increased the tonnage of beets, but decreased the percentage of sugar.

Early planting gave larger yields and slightly higher percentage of sugar.

Clay loam soil produced the largest tonnage and the highest percentage of sugar, followed by other soils in the order below, except that the tonnage on muck is next to clay loam. Sandy loam, sand, clay, muck.

During the past season there was a slight falling off in sugar content of growing beets from October 19th to November 23d.

SUGAR BEET EXPERIMENTS.

The questions relating to soil, temperature, rainfall, length of season and other attendant conditions, which bear on the farmers' interest in the sugar beet industry of this State, have been discussed very fully in former publications of this station.* The industry is now firmly established, and already problems pertaining to the business of growing the crop are calling for solution.

Some of the experiments already undertaken have been suggested by our own experience, while the need of others has been anticipated. The growing of beets continuously on the same ground has been progressing for two years with the view to study insect enemies and fungous diseases that may develop under such practice, while at the same time observations will be made on the growth of soil exhaustion and the cultural effects that may follow.

In the preparation of this bulletin, the work of analyzing fertilizers and testing beets was done under the direction of Dr. R. C. Kedzie, to whom is due the credit for that part of the work.

* Bulletin 150, and special bulletins 8 and 10, Michigan Experiment Station.

PREPARATION OF SEED BED.

The sugar beet is a deep-rooted plant, and it necessarily follows that deep cultivation in the preparation of the seed bed is an absolute necessity. Where the sub-soil is a hard clay, it is essential to use the sub-soil plow. Sub-soiling has generally been looked upon as an expensive and laborious operation. A fifteen-year-old boy with a light team operated the sub-soiler on the College farm last spring, doing good work with comparative ease. The surface plowing and sub-soiling were each seven inches deep, thus giving fourteen inches of mellow soil for the beets. The spring sub-soiling, however, proved disastrous, as the ground did not regain a sufficient supply of moisture to support the crop.

In soils with a loose, sandy sub-soil, the use of the sub-soil plow is unnecessary, as the roots easily find room for deep growth, while rain water and available plant food are readily carried down to any depth.

Preparation of the soil approaches perfection as we increase, to a normal supply, the amount of organic matter, provided it is in a well rotted condition and is thoroughly incorporated with the soil. It therefore follows that stable manure and green manures are advantageous when applied some time before the beets are sown. It will be seen by a study of some of the tables which follow that stable manure has increased the yield without materially lowering the per cent of sugar. In fact, the average from several co-operative soil test experiments shows an increased per cent of sugar on the plots which received coarse manure over the unfertilized plots, while the highest per cent of sugar was generally obtained from the soil receiving potash and phosphoric acid only.

Where coarse manure was applied, on sandy loam soil, two months or more before the ground was plowed, no serious injury to the formation of the beets was noticed, and where well rotted manure was applied on the plowed ground and harrowed in, well formed beets of a high per cent of sugar were produced.

Where coarse manure was applied just prior to plowing the ground and sowing the seed, many ill-formed beets were found with numerous branching horizontal roots. Upon pulling these beets coarse manure was found clinging to the roots.

Aside from thorough deep plowing and supplying organic matter the lower soil should be well firmed and united with the sub-soil to avoid any check to the capillary flow.

The surface preparation should be as complete as required in the best prepared garden and should continue thoroughly until the day the seed is planted, thereby giving the beet seed at least an equal chance with the weeds.

RELATIVE AMOUNTS OF FERTILIZING ELEMENTS TO APPLY.

The question how much nitrogen, phosphoric acid and potash shall be applied, and what relation shall these elements bear to each other, is one that can only be answered by consulting several individual soils and conditions. The following experiments, many of which we hope to continue on the same soil for a number of years, were designed to answer these questions.

EXPERIMENT A.

A piece of light sandy soil in very good tilth was divided into ten uniform plots, 1-20 acre each, and treated according to the table below. Two plots were devoted to normal applications of all three elements, nitrogen, phosphoric acid and potash; a plot for each of these elements on which double applications were made in connection with normal amounts of the remaining two, a plot each with normal amounts of two elements, leaving out one, and a plot receiving no fertilizer.

TABLE 1.—*Showing the amount of fertilizer applied, and the yield and analysis of beets.*

Plot No.	Fertilizing element.	Fertilizing materials used.	Pounds per acre.	Yield of beets pounds per acre.*	Per cent of sugar in juice.	Co-efficient of purity.
1	No fertilizer			11,025	11.60	74.1
2	Normal application	Nitrate of soda Dissolved phosphate rock Muriate of potash	200 400 200	17,553	11.84	73.5
3	No nitrogen Normal phosphoric acid and potash	 Dissolved phosphate rock Muriate of potash	 400 200	12,425	12.24	74.5
4	Double nitrogen Normal phosphoric acid and potash	Nitrate of soda Dissolved phosphate rock Muriate of potash	400 400 200	13,825	11.36	71.7
5	No phosphoric acid Normal nitrogen and potash	 Nitrate of soda Muriate of potash	 200 200	14,525	12.61	77.6
6	Double phosphoric acid Normal nitrogen and potash	Dissolved phosphate rock Nitrate of soda Muriate of potash	800 200 200	22,540	11.95	76.1
7	No potash Normal nitrogen and phosphoric acid	 Nitrate of soda Dissolved phosphate rock	 200 400	20,825	12.21	75.8
8	Double potash Normal nitrogen and phosphoric acid	Muriate of potash Nitrate of soda Dissolved phosphate rock	400 200 400	19,250	13.	78.1
9	Normal application	Nitrate of soda Dissolved phosphate rock Muriate of potash	200 400 200	18,200	13.47	79.
10	Ammonia nitrogen Normal phosphoric acid and potash	Sulphate of ammonia Dissolved phosphate rock Muriate of potash	152 400 200	14,000	11.71	75.6

* After deducting dockage.

Analyses of the above fertilizer will be found on page 230.

This experiment being tried on land comparatively rich in organic matter, it having for several years previously been occupied by a growth of lathyrus sylvestris, and this being the first year, these results are in no way conclusive. It might, however, be observed that the land responded to every application of fertilizer, as shown by increased yields over the no-fertilizer plot, and that the phosphoric acid seemed to be the most beneficial. It is unsafe, however, to draw any conclusions as yet from the effect of fertilizing elements on the content of sugar. This experiment will be continued on the same ground, using similar fertilizers.

EXPERIMENT B.

A co-operative soil test experiment has been conducted the past season in which sugar beets were one of the several crops. Below are the names of men who conducted successful experiments with sugar beets:

*O. C. Wheeler, Belding, Ionia county; L. B. Walton, Dryden, Lapeer county; Bruce Phillips, Utica, Macomb county; Glen C. Lawrence, Ypsilanti, Washtenaw county; H. M. Kingsley, Kendall, Van Buren county; *C. E. Mills, Mancelona, Antrim

* Beets were not analyzed.

county; *L. R. Williams, Otsego Lake, Otsego county; †A. E. Gregory, Dowagiac; Parmelee Farm, Meridian, Ingham county; College Farm, Agricultural College, Ingham county.

This experiment aimed to test several soils, generally pretty well exhausted, to determine which of the three fertilizing elements, nitrogen, phosphoric acid and potash, were most needed, and what effect their application would have on the growing crop. The plan is not a new one, it having been published by the Office of Experiment Stations some twelve years ago in Circular No. 7, pages twenty-four to twenty-eight, and adopted for this kind of work by a large number of experiment stations.

In the table below the kind of soil is indicated and the kind and amount of fertilizers applied. The results on the College farm and in the Walton, Phillips, Lawrence and Gregory experiments are given. A complete result of experiments with other crops will be published in another bulletin.

* Beets were not analyzed.
† Experiment conducted in the extreme southern part of Van Buren county.

TABLE 2.—*Results of Co-operative Soil Test Experiments with Sugar Beets.*

Number of plot.	Fertilizing material applied.	Amount of each material applied per acre, pounds.	Total fertilizer applied, pounds.	Farm of G. C. Lawrence, Ypsilanti, Washtenaw Co. Sandy soil. Yield per acre, pounds.	Per cent sugar.	Purity.	Farm of Bruce Phillips, Utica, Macomb Co. Sandy loam soil. Yield per acre, pounds.	Per cent sugar.	Purity.	Farm of A. E. Gregory, Keeler T'p, Van Buren Co. Sandy loam soil. Yield per acre, pounds.	Per cent sugar.	Purity.	Farm of L. B. Walton, Dryden, Lapeer Co. Clay loam soil. Yield per acre, pounds.	Per cent sugar.	Purity.	College Farm, Meridian T'p, Ingham Co. Sandy loam soil. Yield per acre, pounds.	Per cent sugar.	Purity.	Average five farms. Yield per acre, pounds.	Per cent sugar.	Purity.
1	No fertilizer	......	......	1,496	......	......	4,108	14.33	83.17	6,770	......	......	4,960	15.97	79.49	......	......	......	4,334	14.58	81.33
2	Nitrate of soda	120	120	1,984	13.55	78.64	5,547	14.44	83.45	9,989	14.59	81.7	7,860	16.71	80.77	9,515	13.88	68.8	6,979	14.63	78.67
3	Dissolved phos. rock	240	240	4,152	14.19	84.41	3,380	14.96	81.75	9,657	16.23	81.2	9,740	16.49	80.48	8,148	13.90	78.5	7,015	15.15	81.27
4	Muriate of potash	120	120	6,000	13.39	80.47	1,308	13.94	81.56	12,072	15.58	80.	5,460	18.69	83.85	10,276	15.70	82.	7,021	16.06	81.58
5	No fertilizer	......	......	5,304	13.12	83.94	2,088	14.42	83.46	12,829	14.62	81.9	6,600	......	......	7,042	12.15	76.8	6,773	13.65	81.5
6	Nitrate of soda Dissolved phos. rock	120 240	360	6,048	13.	80.01	2,516	15.39	83.58	11,646	16.16	86.6	9,540	16.02	81.36	8,777	13.64	79.	7,705	14.86	82.11
7	Nitrate of soda Muriate of potash	120 120	240	8,585	13.50	80.26	2,994	14.45	81.65	11,872	14.69	80.	8,280	15.42	80.77	9,688	15.17	81.	8,248	14.65	81.10
8	Dissolved phos. rock Muriate of potash	240 120	360	8,816	13.61	81.79	4,031	14.97	84.91	8,570	16.60	83.1	8,580	15.58	81.61	9,327	15.69	83.4	7,865	15.29	82.96
9	No fertilizer	......	......	8,080	11.90	82.43	3,764	15.28	83.82	7,953	15.77	83.1	6,720	......	......	9,420	13.44	76.7	7,187	14.10	81.56
10	Nitrate of soda Dissolved phos. rock Muriate of potash	120 240 120	480	9,600	14.88	82.43	5,084	14.05	82.50	8,332	17.47	85.2	11,880	16.34	81.33	11,471	15.22	81.9	9,273	15.59	82.67
11	Commercial fertilizer	480	480	5,120	13.12	84.45	4,605	15.11	82.88	5,918	16.85	83.1	10,480	......	......	9,891	13.87	79.8	7,203	14.74	82.56
12	Stable manure	20 loads.		5,408	14.77	81.92	9,654	13.73	79.69	*7,006	16.54	83.6	12,620	15.52	80.46	10,802	13.06	78.5	9,098	14.72	80.83
13	No fertilizer	......	......	......	......	......	4,553	13.61	81.78	......	......	......	5,780	17.25	85.02	......	......	......	......	......	......
	Average of no fertilizer plots	......	......	4,993	12.51	83.18	3,628	14.41	83.06	9,184	15.20	82.5	6,015	16.61	82.26	8,231	12.94	76.8	6,098	14.11	81.46

* Stable manure applied as top dressing and harrowed in.
Analyses of the above fertilizers will be found on page 230.

We are never sufficiently sure of the first year's results of any fertilizer experiment to warrant us in drawing definite conclusions.

Looking at the average yields, there is nothing particularly significant, except that no one, nor even two, elements seem to satisfy the demands of the beet crop. The best results come from an application of a complete home mixed fertilizer, costing $27.50 per ton, and applied at the rate of 480 pounds per acre. The average yield from home mixed fertilizer exceeds that of stable manure, while its per cent of sugar is .87 greater, and co-efficient of purity 1.84 higher.

In the matter of per cent of sugar and purity from the single elements, potash gives the highest and nitrogen the lowest, and though nitrate of soda produced beets with higher per cent of sugar than any one of the no-fertilizer plots, its co-efficient of purity is the lowest.

*Maerker found that increasing the nitrogen in stable manure by using manure that had been protected, he decreased slightly the per cent of sugar and co-efficient of purity, but the correspondingly increased tonnage of beets gave a very marked increase in yield of sugar per acre.

†Van Slyke states that in 1898 the application of fertilizers did not affect the average per cent of sugar. He further summarizes that stable manure increases the average yield 8,720 pounds per acre, the percentage of sugar 1.5 per cent, and the co-efficient of purity 1.6.

‡At Cornell in 1898, fertilizer increased the per cent of sugar .54, and the co-efficient of purity 3. Nitrate of soda grew large beets of low quality.

**The above results are in accord with West Virginia experiments.

It seems that nitrate of soda alone generally produces beets of low per cent of sugar, but when used in connection with sufficient amounts of the other two elements, normal beets are produced. Hence, we may conclude that the per cent of sugar is not so much reduced by the presence of the nitrate as by the absence of available phosphoric acid and potash.

EXPERIMENT C.

On a portion of field number six of the College farm another fertilizer test was conducted. The soil was a sandy loam and medium in fertility. Table number three gives the plots arranged in their order, with the kind and amount of fertilizer applied, together with the yield in pounds per acre of cleaned and trimmed beets, the percentage of sugar and the co-efficient of purity. Beets of the Zehringen variety were grown in this experiment.

The stable manure was hauled from the cow barn the day before the plowing was done. The sugar beet fertilizer was a brand offered by one of our leading manufacturers, and contained about two per cent of ammonia, eight and one-half per cent total phosphoric acid, mostly soluble, and five per cent potash. The complete fertilizer consisted of a mixture of one hundred twenty pounds nitrate of soda (18.71% ammonia), two hundred and forty pounds dissolved phosphate rock (1.82% insoluble and 15.85% available P_2O_5), and one hundred twenty pounds muriate of potash (49.85% K_2O). The above fertilizers, together with all the chemicals used in the experiments, were applied one week before the seed was sown. Where ammonia nitrogen was applied, ninety-five pounds of sulphate of ammonia (25.38% ammonia) replaced the one hundred twenty pounds of nitrate of soda, thereby supplying practically the same amount of nitrogen.

The sulphate of potash applied contained 49.10% K_2O and the lime 60.7% CaO. The hen manure consisted largely of straw taken from the scratching pens and was applied as a mulch after the beets were thinned. The mulch was applied with a view to keep down the weeds, hold the moisture and provide a small supply of plant food.

Plots eighteen to twenty-two, inclusive, were on a separate portion of the field, where the seed was sown at a later period and the other conditions were such that comparisons with the rest of the field are unfair and misleading. The relation of the yields on these plots as compared with the nothing plot number eighteen give some

* Landwirtschaftliche Jahrbücher XXVIII Band.
† New York Agricultural Experiment Station Bulletin No. 155
‡ Cornell Experiment Station Bulletin No. 160.
** West Virginia Experiment Station Bulletin No. 55.

idea of the relative merits of these latter fertilizers in comparison with those in the former portion of the experiment.

The wood ashes contained 1.95% potash and 1.46% phosphoric acid. Home mixed fertilizer was made up of three hundred pounds dissolved phosphate rock, fifty pounds nitrate of soda, fifty pounds of sulphate of ammonia and one hundred pounds of sulphate of potash (plot 21).

TABLE 3.—*Fertilizer experiments on the College Farm, Field No. 6.*

Plot No.	Fertilizers.	Amount per acre.	Pounds of cleaned and trimmed beets per acre.	Per cent of sugar.	Purity.
1	Barn yard manure	20 loads	14,310	14.29	81.6
2	Sugar beet fertilizer	480 lbs.	12,560	15.22	81.9
3	Sugar beet fertilizer Air-slaked lime	480 lbs. 1 ton	14,350	14.33	79.1
4	No fertilizer		16,510	15.23	82.7
5	Complete fertilizer (nitrate nitrogen)	480 lbs.	15,630	15.25	82.2
6	Complete fertilizer (nitrate nitrogen) Air-slaked lime	480 lbs. 1 ton	17,750	15.48	88.2
7	Complete fertilizer (ammonia nitrogen)	455 lbs.	15,000	15.10	83.2
8	Complete fertilizer (ammonia nitrogen) Air-slaked lime	455 lbs. 1 ton	14,630	15.78	79.4
9	No fertilizer		12,870	14.99	82.7
10	Dissolved phosphate rock Muriate of potash	250 lbs. 250 lbs.	16,330	14.75	82.1
11	Nitrate of soda	250 lbs.	13,680	15.34	82.1
12	Sulphate of ammonia	190 lbs.	13,620	13.98	83.3
13	Air-slaked lime	1 ton	14,960	15.21	81.8
14	No fertilizer		13,660	15.17	83.2
15	Dissolved phosphate rock Muriate of potash	250 lbs. 250 lbs.	14,440	16.12	83.2
16	Sulphate of potash	250 lbs.	14,070	14.39	81.7
17	Hen manure (top dressing)		13,260	15.25	82.
18	No fertilizer		11,300	15.22	81.
19	Wood ashes	2,000 lbs.	12,000	14.48	80.8
20	Sugar Beet Home Mixture	500 lbs.	11,900	15.95	82.
21	Sugar Beet Fert. Commercial	500 lbs.	10,280	14.59	82.7
22	Salt	2,000 lbs.	13,950	13.73	80.9

Throughout the period of growth there was a slightly greater development of leaf on the plots receiving lime than those under similar treatment, though unlimed; while to the credit of nitrate of soda was earlier germination and a decidedly greater development of the plants all through the first half of the season.

Attention is called in the following table to the effect of nitrate of soda as compared with sulphate of ammonia, as a fertilizer for sugar beets:

	In complete fertilizer. Plots 5 and 7.		In complete fertilizer with lime. Plots 6 and 8.		Alone. Plots 11 and 12.	
	Yield pounds.	Per cent sugar.	Yield pounds.	Per cent sugar.	Yield pounds.	Per cent sugar.
Nitrate of soda	15,630	15.25	17,750	15.48	13,680	15.34
Sulphate of ammonia	15,000	15 10	14,630	15.78	13,620	13.98
Gain in favor of nitrate of soda	630	.15	3,120	—.30	60	1.36

The yield in every case was in favor of nitrate of soda, while the varying per cents of sugar leave that feature of the question still very inconclusive.

Comparing plots nine and ten in table one, page 227, we find that nitrate of soda produced 4,200 more pounds of beets per acre, which were 1.76% richer in sugar, with a material increase in the co-efficient of purity.

In connection with the College Farm soil test experiment a comparison of ammonia and nitrate nitrogen was made. The soil was medium loam and of uniform character, dissolved phosphate rock and muriate of potash applied in like quantities in each case.

	Yield per acre.	Per cent sugar.	Purity.
Complete fertilizer (Nitrate nitrogen)	11,471	15.22	81.9
Complete fertilizer (Ammonia nitrogen)	9,688	12.69	67.
In favor of nitrate nitrogen	1,783	2.53	14.9

*Maerker found but little difference in results where 600 kilograms of nitrate of soda per hectare in three applications of 200 kilograms each were made in comparison with 450 kilograms of sulphate of ammonia. Nitrate of soda produced 1,600 more kilograms of beets per hectare, while the ammonia produced beets with .9% more sugar, thereby producing 86 kilograms more sugar per hectare than the nitrate of soda. He further states that the results were more favorable where half of the nitrogen was applied in form of nitrate and half in the form of ammonia.

LIME AS A FERTILIZER FOR SUGAR BEETS.

In connection with the fertilizer experiment in field No. 6, a comparison of the effect of lime on a growing crop was also made.

Where the plots limed and unlimed were compared they were adjacent and otherwise uniformly treated, the application of lime being at the rate of one ton per acre. Below are figures taken from table No. 3 showing the results of the effect of lime:

Fertilizer.	Limed.—1 ton per acre.			Unlimed.		
	Yield, pounds per acre.	Per cent sugar.	Purity.	Yield, pounds per acre.	Per cent sugar.	Purity.
Sugar beet fertilizer	14,350	14.33	79.1	12,560	15.22	81.9
Complete fertilizer (Nitrate nitrogen)	17,750	15.48	82.2	15,630	15.25	82.2
Complete fertilizer (Ammonia nitrogen)	14,630	15.78	79.4	15,000	15.1	83.2
No fertilizer	14,960	15.21	81.8	13,660	15.17	83.2
Average	15,423	15.20	80.6	14,213	15.19	82.6

These figures on the average show an increased yield of 1,210 pounds per acre, and a slight decrease in the purity from liming, while the percentage of sugar remains practically the same.

The figures below were taken from table No. 4 of experiments on muck land, and show from an average of seven plots, limed and unlimed, as follows:

Seven plots, limed, yield per acre, 11,580 pounds; per cent of sugar, 7.68; purity, 69. The same fertilizers and conditions existing on a similar area, though unlimed, gives a yield of 12,883 pounds per acre; per cent of sugar, 9.64, and purity, 72.61, or over eleven per cent more beets; nearly two per cent higher in sugar, and 3.61 higher purity.

* Landwirtschaftliche Jahrbücher Band XXVIII.
A kilogram=2.204 pounds.
A hectare=2.471 acres.

It will be seen that so far our results with lime on the high land contradict those produced upon the muck. Further work of this character will be conducted, making more thorough applications of the lime, on new land and continuing it on the same soil.

The application of lime to some soils, especially the older soils of the east, show marked beneficial results.

*In Rhode Island, in 1893, with nitrate nitrogen, the yield of sugar beets was increased 12.17 times by applying air slaked lime at the rate of 2.7 tons per acre, by adding another half ton the following year the yield was still eleven times greater than the unlimed plot.

†West Virginia Experiment Station gives no tables of yields, but states from a comparison of nine plots unlimed and nine limed with thirty bushels air slaked lime per acre, that the application of lime "reduced the sugar content and the percentage of purity."

DATE OF PLANTING.

The experience of the German farmers and the fact that such roots as the table beet, Swedish turnip and mangel wurzels admit of a wide range in the date of planting led us to conduct this experiment.

As soon as the temperature of the ground had reached a degree that would germinate the seed, say 50° F., planting was begun and continued every week for six weeks. The ground selected for the experiment was dry and light, having produced beets the previous year. An application of commercial fertilizer—500 pounds per acre—was made a few days previous to sowing the seed. The dates of sowing were April 22, April 29, May 6, May 13, May 20 and May 27.

The first planting was up in nine days; the second in seven; the third in nine, while the last three plantings required about seven days to germinate and prick through the ground.

Cultivation with hand tools was begun as soon as the rows were visible and performed twice before thinning. The first planting was thinned May 22, and the second ready as soon as the first was finished.

The growth of plot three was checked by the severe cold weather which followed the time of its planting, while plots one and two seemed to be but little affected by the cold weather at that time.

Plots four, five and six grew normally, and after they were thinned, June 10 to 18, appeared to be overtaking the earlier planted beets. Through the dry period, during July and August, the later planted beets showed signs of greater thrift than their older neighbors. When the summer drouth, about August 30, was at its height, the leaves of the early planted beets had completely died and all indications pointed to a complete failure of the crop, but the yields shown in the table below present a very different result. When the fall rains came, the beets all revived, threw out new leaves and made a marked development of root.

Table of results showing yield per acre and percentage of sugar in beets planted at different times.

Time of planting.	Beets came up.	Ready to thin.	Yield per acre.	Per cent sugar.	Co-ef. purity.
April 22	May 1	May 20	18,095	13.27	81.4
" 29	" 6	" 23	18,300	13.55	79.75
May 6	" 15	June 1	18,250	14.17	82.5
" 13	" 20	" 7	16,570	11.29	73.4
" 20	" 27	" 12	15,190	13.22	79.2
" 27	June 2	" 18	11,875	13.25	78.4

It will be seen by the above that there is a decided advantage in the matter of yield in favor of early planting, while the percentage of sugar differs only .02% between the first and the last planting, and co-efficient of purity but 3.

The marked decrease in yield from the later sown seed is most probably due to the

* Annual report Rhode Island Experiment Station, 1894, p. 158.
† Bulletin 55, West Virginia Experiment Station, p. 187.

extraordinary drouth and would not likely occur were the conditions normal. If one will study the following table he can realize how the unnatural conditions of weather might seriously decrease the yield of late sown beets.

Table of temperature and rainfall by weeks during growing period of beet crop, summer of 1899.

Week ending.	Max. temp. Degrees F.	Min. temp. Degrees F.	Av. temp. Degrees F.	Rainfall. Inches.
April 7	45	10	31.5	0
" 14	79	26	49.5	.04
" 21	80	32	55.9	.24
" 28	83	45	68.1	.18
May 5	86	42	66.3	1.58
" 12	75	42	62.1	.48
" 19	75	37	52.1	1.22
" 26	79	34	57.6	.16
June 2	83	54	66.4	1.25
" 9	89	52	74.	.57
" 16	87	45	67.4	.30
" 23	92	43	71.	0
" 30	83	45	69.8	.28
July 7	89	62	71.9	.97
" 14	86	50	67.8	.56
" 21	86	48	70.9	.23
" 28	96	53	74.2	.35
August 4	87	43	69.7	.03
" 11	90	47	71.2	.12
" 18	95	41	69.7	0
" 25	97	51	74.6	Trace.
September 1	93	51	75.5	.55
" 8	94	44	71.	.67
" 15	75	31	57.5	0
" 22	91	32	58.9	.84
" 29	62	27	47.9	.63
October 6	74	21	44.3	0
" 13	83	31	59.1	Trace.
" 20	81	31	53.5	1.04
" 27	80	36	57.6	.60
November 3	60	28	40.2	2.05
" 10	59	23	37.9	.23
" 17	57	28	41.6	.46
" 24	60	27	43.3	Trace.
December 1	50	28	39.4	.02

In Colorado,* 1898, early planting on the Experiment Station farm gave highest results in per cent of sugar, yield of beets and yield of sugar per acre. While at Rocky Ford, in the same state, there was in planting from April 18 to June 1 a gradual increase in per cent of sugar, but a decrease in average weight of beets, tonnage per acre, and the resultant sugar.

From the above we may decide that it is safe and wise to plant beets as early in the spring as we do any farm crop, that prolonging the date of planting gives a longer period for thinning and, in ordinary years, should lengthen the season of ripening and harvesting, and finally that the date of planting seems to have but little influence on the percentage of sugar.

Dr. Wiley says, "Beets should be planted as early in the spring as possible."

* Colorado Experiment Station Bulletin No. 51.

BEET EXPERIMENTS ON MUCK LAND.

In a portion of field No. 13, on some muck soil where fertilizer experiments were begun in 1898, the effect of these fertilizers was tested the past year on sugar beets. This soil is well underdrained and has been in crops for the past twelve or fourteen years. The muck varies in depth from two to six feet and is thoroughly subdued. The beets were sown in this field June 9, a little later than on the remainder of the farm, and afterwards given similar care. Owing to the fact that this soil is more free from weeds, the cultivation was much easier and less frequent. The beets in all of our muck experiments, however, seemed to suffer as much or even more during the severe summer drouth than did those on the heavier land. At the time of harvesting, the muck land beets were apparently making a stronger growth than they had at any other time during the season, and the indications were that had the season been prolonged still one more month, good yields of beets could have been obtained. Below is a table showing the amounts of fertilizers and yield of beets per acre, together with their percentage of sugar and co-efficient of purity:

TABLE 4.—*Beet experiments on muck land.*

	Fertilizers applied.	Rate per acre. Pounds.	Yield per acre. Pounds.	Per cent sugar.	Purity.	Average weight of beets. Ounces.
1	Nothing		3,432	8.86	70.	9
2	Air-slaked lime (in 1898)	4,000	2,640	8.29	68.57	14
3	Leached ashes (in 1898)	10,000	12,078	10.21	76.36	9
4	Sand (layer one inch thick)		9,702	8.05	69.31	8
5	Commercial fertizer		2,310	8.70	76.65	12
6	Home mixed fertilizer		6,996	7.54	71.74	10½
7	Stable manure (20 loads per acre)		16,434	7.14	62.86	16
8	Nothing (land thoroughly rolled)		7,392	7.93	71.51	10
9	Nitrate of soda	400	13,446	10.62	74.52	5
10	Dissolved phosphate rock	800	6,791	10.47	78.78	6
11	Muriate of potash	400	16,929	11.80	79.88	5½
12	Nitrate of soda Dissolved phosphate rock	400 800	9,639	7.20	60.76	7
13	Nitrate of soda Muriate of potash	400 400	17,037	9.01	74.16	11½
14	Dissolved phosphate rock Muriate of potash	800 400	16,001	8.99	71.29	14
15	Nitrate of soda (lime one ton)	400	8,748	6.63	65.32	9
16	Phosphate rock " " "	800	5,616	6.98	68.77	6
17	Muriate of potash " " "	400	11,367	8.29	71.77	12
18	Nitrate of soda " " " Phosphate rock " " "	400 800	10,680	6.53	62.57	9
19	Nitrate of soda " " " Muriate of potash " " "	400 400	16,038	9.13	69.37	7
20	Phosphate rock " " " Muriate of potash " " "	800 400	16,929	7.23	67.63	5
21	Nothing		10,341	9.40	76.92	3
22	Lime	2,000	11,681	9.01	76.65	9½
23	Lime	4,000	15,687	8.18	75.11	7½
24	Lime	6,000	16,821	6.73	68.04	10
25	Unleached ashes	2,000	23,814	10.15	78.3	14

From the above it will be observed that the highest yield of beets resulted where unleached ashes were applied. While throughout the experiments applications of potash resulted in very marked increased yields, coupled with a rise in the percentage of sugar. This indicates that the soil is perhaps more in need of this mineral than any other one element. Where phosphate rock is used the increased yield over the nothing plots is not so marked; indeed, where phosphate rock alone at the rate of eight hundred pounds per acre was applied, the yield was lower than that on a plot near by receiving no ferti-

lizer, though thoroughly rolled. Noting the plot on which nitrate of soda and phosphate rock were applied the yield is less than on the plot receiving nitrate of soda alone, indicating an injurious effect from the application of the phosphoric acid.

Particular interest is centered on the results from applying sand, which seems to supply even better than carefully compounded fertilizers some of the demands of this soil. The yield of beets and the percentage of sugar is very satisfactory under this application. For the excellent yields on the nothing plot where land was thoroughly

PLATE NO. I.

1. Nothing. 2. Air-slaked lime. 3. Leached ashes. 4. Sand. 5. Commercial fertilizer. 6. Home mixed fertilizer. 7. Stable manure. 8. Nothing. Thoroughly rolled.

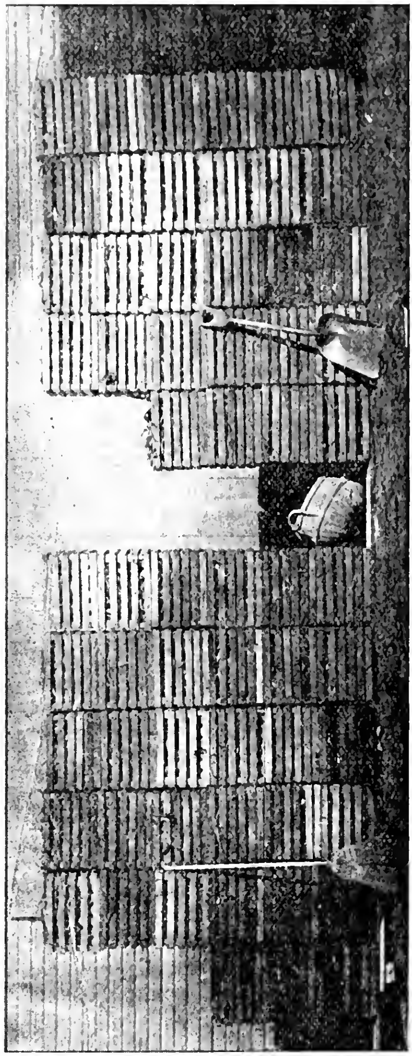


PLATE NO. II.

Unlimed. Limed. (1 ton to the acre.)

rolled, we can give no other reason than that this soil held the moisture better during the drouth than did the other plots.

On the effect of application of air slaked lime the results are very unsatisfactory and somewhat contradictory. Where the lime was applied in 1898 at the rate of two tons per acre, its effect on this crop, as well as others grown on the same plot, seems

to be absolutely injurious, while comparing the results from applications made this year (1899), plots 21-24, we find a gradual increase in yield as more lime was applied, coupled with a corresponding decrease in the percentage of sugar and the co-efficient of purity.

Again, comparing plots nine to fourteen with fifteen to twenty, where treatment was the same, with the exception of an addition of lime, we find generally a falling off in the yield, which is also accompanied by decrease in the percentage of sugar and co-efficient of purity.

TEST OF VARIETIES.

Variety tests have been conducted during the past two years, using each year the varieties of seed that have been at hand.

Below is a table giving yields per acre each year, and results of analyses of the same:

TABLE 5.—*Test of varieties.*

Name of variety.	1898.			1899.		
	Yield per acre. Pounds.	Per cent sugar.	Purity.	Yield per acre. Pounds.	Per cent sugar.	Purity.
Zehringen	19,076	14.03	85.5	10,283	14.00	80.60
Kleinwanzlebener	20,840	12.92	74.2	10,619	13.64	78.50
Vil. Blanche Ameliore	18,061	12.39	78.3	....	....	....
Vilmorin Improved	18,493	12.92	81.8	12,020	12.80	79.10
Kleinwanzlebener	14,114	13.09	77.	....	....	....
Schreiber's Elite	16,556	13.07	80.2	....	....	....
Baumeier's Improved Kleinwanzlebener	18,074	12.36	79.2	....	....	....
Beindorf Elite Kleinwanzlebener	....	....	....	9,110	13.16	77.50
Pitschke Elite	....	....	....	10,289	14.	75.3
Mangold	....	....	....	8,651	15.77	83.
Russian	....	....	....	11,390	14.38	80.90
Rölker's EE	....	....	....	10,874	15.00	83.70
Rölker's ZZ	....	....	....	10,895	15.83	81.40

It should be noted that the above are yields of perfectly clean beets, carefully trimmed for factory purposes, and that the soil on which they were grown is not such as we would select for growing beets were we raising them for commercial purposes. The yields for the two years seem to compare well, relatively, with the yields of beets on the farms of the State.

From the tests of sugar beets made throughout the State with seed furnished by the Department of Agriculture and sent out from this office, the following tables of averages have been arranged:

Reports from 257 farmers who tested Kleinwanzlebener, gave the average percentage of sugar 16.42, and purity 83.3. From 47 farmers testing Vilmorin Improved beets, average 16.50 per cent sugar and 84.4 purity.

EXPERIMENTS ON DIFFERENT KINDS OF SOIL.

The table below is a summary of the experiments made by farmers throughout the State and gives the average analyses from five different kinds of soil, as classified by the men performing the experiments. The average yield in 1899 is also given:

	1897.			1899.			
	No. of analyses.	Per cent sugar in juice.	Purity.	No. of analyses.	Per cent sugar in juice.	Purity.	Tons per acre.
Clay loam	57	16.84	81.7	34	14.90	86.6	16.01
Sand loam	140	16.37	84.	58	14.60	81.1	12.16
Sand	62	16.01	83.5	29	14.70	80.5	11.51
Clay	22	15.90	81.6	8	14.30	79.2	11.33
Muck	4	13.14	78.	15	13.11	78.3	15.11

While the above classification is not in accordance with any fixed rule, we may assume that a mixture of even parts of sand and clay, or varying ten per cent from equal parts, is a superior sugar beet soil.

Looking at the products from muck soil and considering the vast areas of this kind of land in the State, running from black ash and tamarack swamps, with the subsoil only a foot or two from the surface, to the muck deposits going down twenty feet or more, we are confronted with a matter of very great economic importance to the Michigan farmer. These marsh and muck soils in favorable seasons are especially adapted to the growth of root crops, but unless there is a liberal admixture of mineral matter, or alluvial soil in the muck, or the subsoil is so near the surface that the beet roots can penetrate it, beets very low in sugar content, only, may be expected.

Improvement of these soils by fertilizers, cultivation and drainage, and the selection of varieties of beets adapted to such conditions, will form a prominent part of the future experiments with sugar beets.

TIME OF SAMPLING.

To determine the effect of fall growth and weather conditions on the sugar content of beets, specimens were carefully collected on consecutive dates the past season and promptly tested.

The ten days selected for taking the samples covered the period during which most of the beets in the State were harvested for factory purposes.

Date of sampling.	Per cent sugar.	Purity.	Average.	
			Per cent sugar.	Purity.
October 19	14.97	83.	14.74	82.23
" 23	15.20	83.		
" 25	14.41	81.8		
" 27	14.83	82.5		
November 1	14.17	81.2		
" 4	14.17	83.5	13.89	81.03
" 6	13.30	79.3		
" 13	13.97	82.3		
" 15	13.90	78.80		
" 23	14.11	81.23		
Average	14.313	81.66		

The above table shows a general slight falling off in sugar as the season progressed, the first five tests averaging .85 higher than the latter five.

It was not possible on the particular plot where these beets grew to make a test of the growth during the 37 days covered by the experiment, but the weather and soil conditions during this period were so very favorable to plant growth that it is reasonable to assume that the beets grew in size proportionately more than they decreased in sugar content.

On a piece of muck ground comparisons in yield were accurately made on seventeen small plots, which resulted in a growth from October 20, when the yield was 10,630 pounds per acre, to November 23, when the yield was 13,523 pounds, but in the meantime the percentage of sugar decreased from 9.53 to 7.75, and the purity from 74.41 to 69.29.

In Ohio,* in 1897, date of sampling by growers showed a gradual increase in per cent of sugar from September 12 to November 18, while by counties the amount of sugar increased, though very irregularly. In 1898† the results from dates of sampling gave very irregular and inconclusive results.

According to Headden, of Colorado,‡, "Beets may remain unharvested, under favorable conditions, without loss of sugar or weight of crop." And, furthermore, "The weight

* Ohio Experiment Station Bulletin No. 90.
† Ohio Experiment Station Bulletin No. 99.
‡ Colorado Experiment Station Bulletin No. 46.

of the leaves does not increase materially during the last six weeks of the growing season, but during this time the weight of the root increases by 64% of its weight at the beginning of the period, or 39% of the weight of the matured beet."

In 1898, Cooke* found from samples of eight varieties tested October 1, average per cent of sugar to be 15.85, with purity 80.3. The same varieties tested three weeks later gave 16.22% sugar, with purity 77.5,—a gain of .37 in sugar, but a loss of 2.8 in purity. In four tests made October 8, compared with beets from the same source on October 29, gave a loss of .13% sugar content and gain of .07 in purity for the later sampling.

Out of over 500 samples of beets analyzed by the chemist of this Experiment Station, taking the average of ten out of each consecutive fifty, we get the following results:

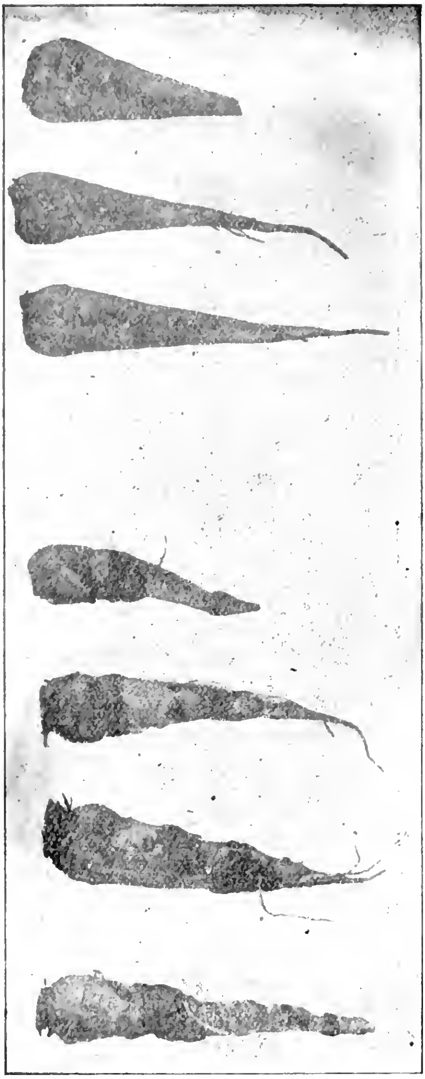
Laboratory numbers.	Per cent sugar.	Purity.	Average. Per cent sugar.	Average. Purity.
1-10	15.24	81.82	14.78	81.29
51-60	15.38	81.48		
101-110	14.29	78.92		
151-160	14.90	81.		
201-210	14.08	83.23		
251-260	13.31	77.57	14.45	79.87
301-310	14.05	79.55		
351-360	14.22	80.76		
401-410	15.55	79.11		
451-460	15.12	82.36		
Average	14.62	80.58		

The above figures show the results from consecutive analyses and are in no way definite. They would, however, indicate approximately what the results would be as beets are delivered at factories, showing a slight decrease as the season progressed, both in percentage of sugar and co-efficient of purity.

The first samples, numbers one to ten, were analyzed about October 15. The work of analyzing the following samples progressed continuously until December 1, when the last samples, numbers 451 to 460, were completed.

* Colorado Experiment Station Bulletin No. 51.

PLATE NO. III.

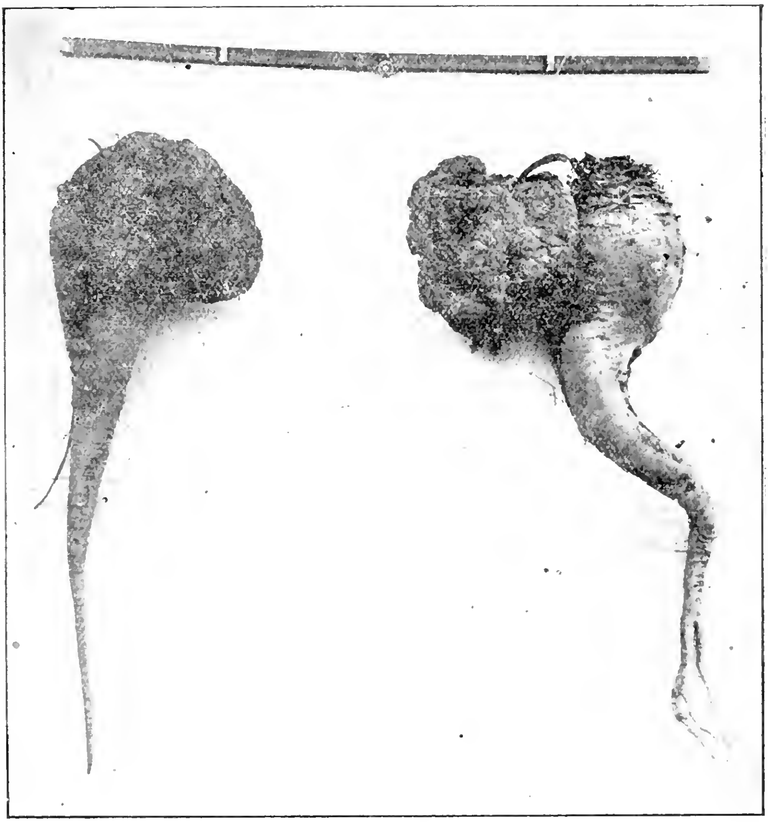


Smooth beets.

Scabby beets.

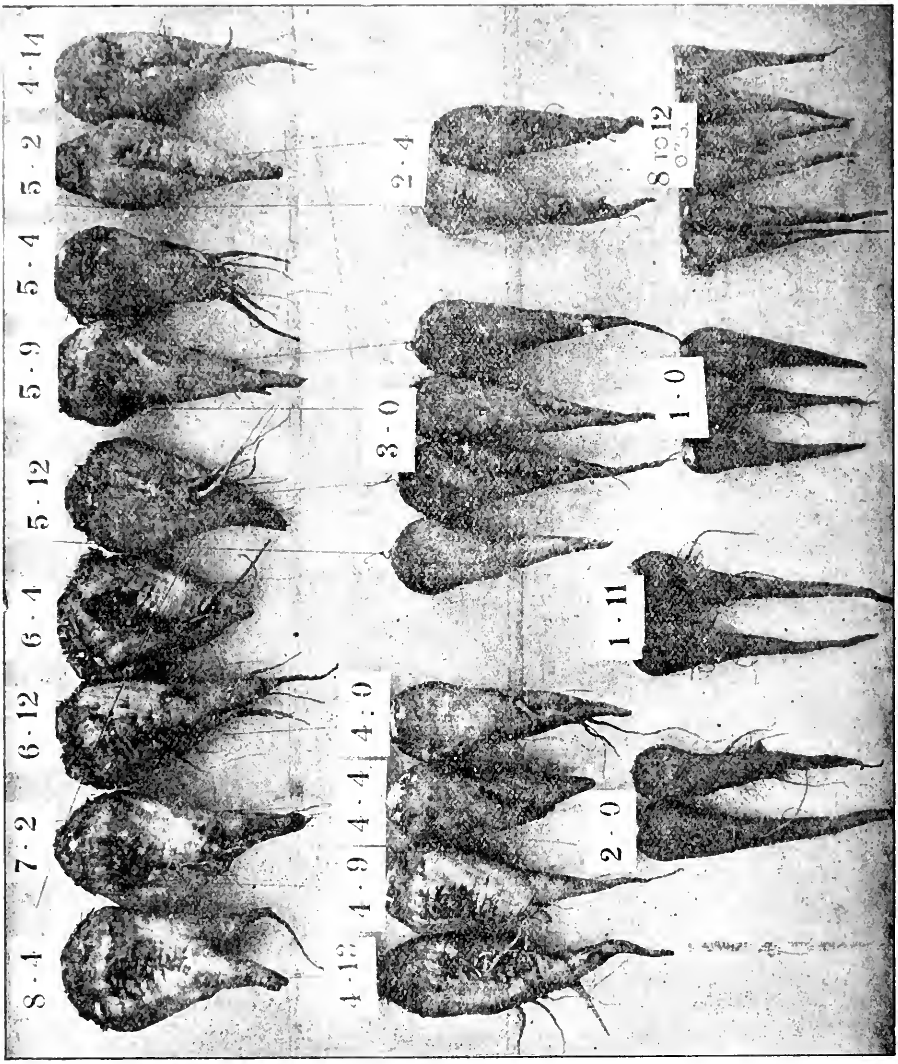
The beets on the left of the above plate are specimens showing beet scab, which prevails in some places, while the right half of the cut shows some typical smooth beets. It is interesting to note that the scabby beets in this instance grew on land adjacent to that on which the smooth beets grew, except that where the scabby beets were produced the ground for years had been used as a potato patch, thus indicating very plainly that old potato patches are to be avoided for beet fields.

PLATE NO. IV.



Crown gall—a disease of sugar beets which is not common in Michigan. Cause not known. Supposed to be due to a fungus—a few specimens observed on the College farm in 1898.

PLATE NO. V.



Relation of size of beets to sugar content.

The accompanying cut is made from a photograph of beets analyzed. The largest beet weighed eight pounds and four ounces and the smallest eight ounces. The weight of each beet is printed over it. The analyses of the beets is given in the next table.

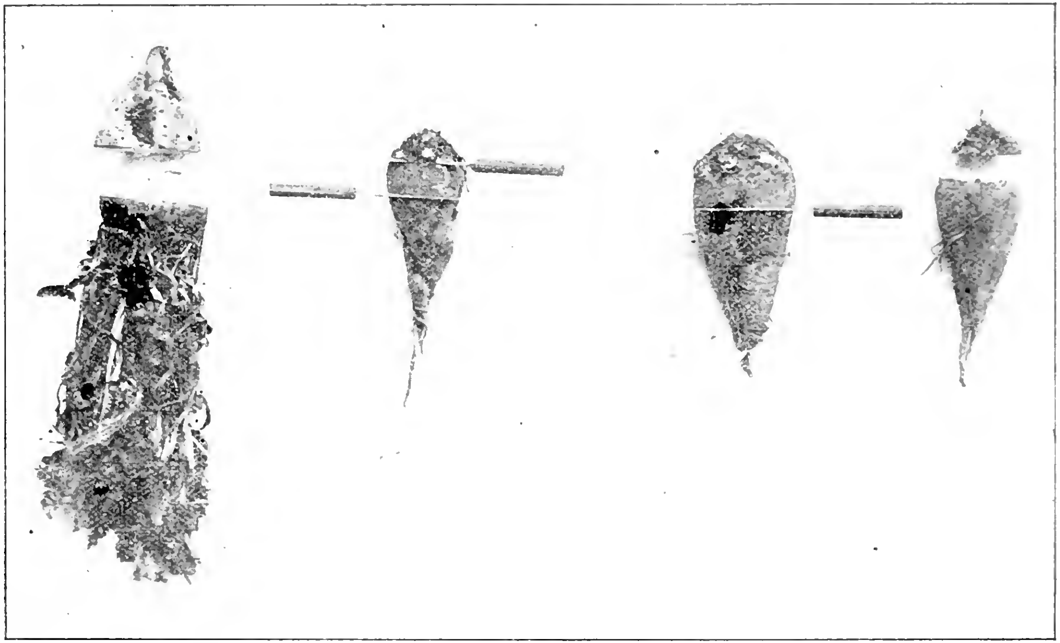
Weight in photograph.		Weight in laboratory.		Weight of trimmed beet.		Loss in trimming.	Per cent of loss in trimming.	Per cent sugar.	Purity.	Average.	
Lbs.	Ozs.	Lbs.	Ozs.	Lbs.	Ozs.	Ounces.				Per cent sugar.	Purity.
8	4	8	3.5	6	0	35.5	27	11.60	75.3	12.53	77.1
7	2	7	1.0	5	2	31.0	27	12.45	78.8		
6	12	6	11.0	5	4	23.0	21	14.14	81.2		
6	4	6	1.0	4	4	29.0	30	13.42	78.0		
5	12	5	11.0	4	6	21.0	23	12.66	75.3		
5	9	5	8.0	4	2	22.0	25	10.92	74.3		
5	4	5	3.0	3	4	31.0	36	13.70	76.1	13.28	78.3
5	2	5	1.0	3	15	18.0	22	12.13	77.7		
4	14	4	12.0	3	15	13.0	17	11.60	77.3		
4	9	4	6.0	3	12	10.0	14	12.89	79.1		
4	4	4	0.0	3	7	9.0	14	14.97	80.5		
4	0	3	13.0	3	0	13.0	21	14.39	79.1		
3	0	3	0.0	....	....	....	....	12.66	80.1	15.72	83.7
2	4	2	4.0	....	....	....	....	15.23	82.8		
2	0	1	15.0	....	....	....	....	16.08	84.6		
1	11	1	11.0	....	....	....	....	16.96	84.8		
1	0	....	....	....	....	4.5	10	16.08	84.6		
	8 to 12	3	6.0	3	2	4.0	7	17.30	85.6		

Plate No. VI shows a lesson in distance apart of planting the beets. Beet number one grew in soil where the head had an abundance of room in which to develop, as did also beets numbers two and three, while number four is a normal beet, growing in properly spaced rows, with near neighbors on either side.

The following are the weights of beet number one: leaves, 36½ ounces; head or top of beet, 26 ounces; trimmed beet, or the portion which would be received at the factory, 28½ ounces. It will be seen that over two-thirds of the growth of this particular plant is not merchantable beet. Beets two and three indicate the amount of waste where beets are grown on hard soil and project a considerable distance out of the ground.

The position of the lower knife in beet number two, and the knife on three, indicates the line of demarkation which separates the portion growing above the ground from that below, and according to instructions from factory men, is the place at which the beet should be trimmed. Beet four is a typical beet, having three and one-half ounces of head and thirty-two ounces of merchantable beet.

PLATE NO. VI.



1. Leaves .... 36½ ozs. Head .... 26 " Trimmed beet .... 28½ "

2. Beets grown with too much room. 3.

4. Typical beet. Head........... 3¼ ozs. Trimmed beet.. 32 "

SOME INSECTS OF THE YEAR 1899.

BY RUFUS H. PETTIT.

Bulletin 180.—Entomological Department.

INTRODUCTORY.

The aim of the present bulletin is to give short accounts of such insects as have attracted special attention during the summer of 1899, together with advice as to remedial treatment. Many other insects have been present and have done injury, but such only were selected as had not recently been noticed in the bulletins of this office.

Correspondence relating to injurious insects is desired, and all aid and advice in our power will be at all times freely and gladly given upon application. The best means we have of finding out the needs of the farmer is through the letters sent us asking for advice in regard to specific insects. In writing for information, it is always best to send one or more of the insects in question or some of their work. A piece of the insect itself is usually more valuable than a lengthy description, and in sending specimens, the best way is to enclose them in a tight tin box, with few if any air-holes (insects require much less air than we do). Together with the insects themselves, it is well to enclose some bits of the natural food for their use on the way. Always label the package with the name of the sender to avoid confusion, as we often receive many boxes at a time.

Never dip specimens in kerosene or other insecticide before sending; in case of scales, put them in a tight tin box.

In sending insects or their work, always address to the Entomologist of the Experiment Station, Agricultural College, Mich.

The writer wishes to extend his thanks to Dr. L. O. Howard and Dr. C. L. Marlatt, of the Department of Agriculture, Washington, D. C.: to Miss Mary E. Murtfeldt of Kirkwood, Mo., and to Prof. Herbert Osborn, of the Ohio State University, for determinations of insects, reference to which is made in each case. He also wishes to express his appreciation and thanks for the many kindnesses shown him by Prof. W. B. Barrows, professor of zoology in the College.

CONTENTS.

THE RED SPIDER.

(*Tetranychus telarius* Linn.?)

A visit to the orchards at the South Haven Fruit-testing Sub-station was made on September 5, and at that time many trees in that region were affected with a mite very closely resembling the red spider, and which probably will prove to be that

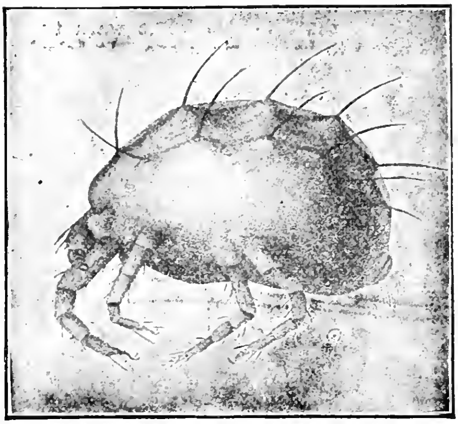


Fig. 1. Red Spider, *Tetranychus telarius*, enlarged. (Original.)

species. Fig. 1 shows one of these mites. It is probably well known that the red spider is not a spider at all, but a mite, and so small that it requires very good eyes to detect it, and a good magnifying glass to see any detail.

The mites here did not confine their attention to one tree, but apparently the same mite infested plum, apple, peach and chestnut. It was also seen on honey locust. The injury was mostly confined to apple, plum and peach.

Unlike the ordinary work of the red spider, no threads of silk were seen, though these may have been present and escaped notice. The little mites were seen in quantity congregated on the under side of the leaves, though they worked on both sides of the chestnut leaves. The leaves of the apple and plum curl downward and the surface becomes uneven and unhealthy looking, almost blistered. The effect on the young trees is quite serious, stopping the growth and stunting the tree. Small apple trees, two or three years old, badly affected, showed very little growth during the past season.

The red spider and all its allies, thrive best in a warm, dry atmosphere, and, as the past season has furnished ideal weather from the standpoint of the mite, it is easy to understand why they became so numerous. It is not likely that they will often become so serious as during the past summer, because our summers are usually more moist. This mite has, however, appeared many times before, both in Michigan and in other states, and has proven itself well worth being placed in the list of out-door pests. Other observers record it, or something very like it, on strawberry, grape, garden plants, pear and other plants. Mr. T. T. Lyon records it on plum in 1875.*

REMEDIES.

In the greenhouse, the remedy is moisture, a spray of water being considered the best remedy when the plants will stand it. Out of doors almost any contact insecticide, such as kerosene emulsion, soft soap and water, whale oil soap, etc., will keep the pest in check if it can be made to reach it. The leaves being curled slightly and

* Rep. Secy. State Pomological Society of Michigan, 1874-5, pp. 233-249.

curled inward, always act as shields for the mites. In order to reach them, a nozzle that will admit of spraying upward from beneath, like the cyclone nozzle, or some side delivery type of the Vermorel, must be used. The spray must be forcibly applied and each tree must be thoroughly treated.

THE EUROPEAN FRUIT-SCALE.

(*Aspidiotus ostreæformis*, Curtis.)

It is the unpleasant duty of the entomologist to warn the fruit-growers of a new pest which possibly will prove to be a serious one. It belongs to the group of scale insects and very closely resembles the eccentric scale, sometimes called Putnam's scale. It is, however, much more prolific and sometimes forms a crust of superimposed scales, which is conspicuous, over the limbs and trunk of a tree. This insect was discovered

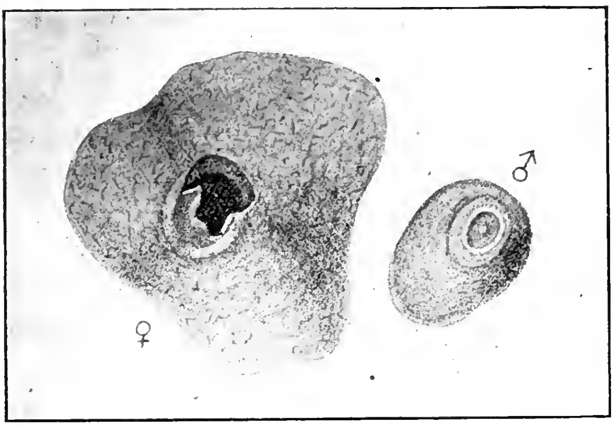


Fig. 2. European Fruit-scale, *Aspidiotus ostreæformis*, scale of male and female. (Original.)

in America during the past year (1899) by Mr. Theo. Pergande, of the Division of Entomology, Department of Agriculture, Washington, D. C.

In an article on the subject, Dr. C. L. Marlatt,* assistant entomologist of the Department of Agriculture, states that the scale is now in New York, Ohio, Michigan, British Columbia, Ontario, Can., and Iowa. He gives a list of food plants, including apple, plum, pear, cherry, prune, *Populus tremuloides* (aspen), *Platanus orientalis*, date palm, *Calluna vulgaris*, oak and white oak. The writer has found it also on silver maple (*Acer dasycarpum*), mountain ash, and currant.

When material, suspected of belonging to this species, was first found, it was sent to Dr. L. O. Howard, entomologist of the Department of Agriculture, who kindly verified the specimens for the writer until subsequent familiarity with this species made determination at the home station certain and accurate.

On account of the extremely close resemblance of this scale to one or two other species, it was found much more satisfactory to compare suspected material with authentic specimens than to work from descriptions alone.

The insect is a well-known fruit pest in Europe and probably was introduced into this country as early as 1890. One case in the State is thought to have been infested from a shipment of plum trees received from an eastern nursery about nine years ago.

In our State there are known to be few localities infested, and these few are well defined and none of them in or near nurseries. The scale has killed several fine, large,

* Science July 7, 1899, pp. 18–20.

soft-maple trees, and others are very sickly, while on the other hand, other trees growing apparently under the same conditions, except for the presence of the scale, are vigorous.

Currant bushes suffered severely, but after treatment have recovered quite well. Two large mountain ash trees show the effects of the scale by a very sickly appearance.

The worst case on record in Michigan was that of an old orchard, visited by Mr. Trine, State Inspector of Orchards and Nurseries, on information obtained from this office. This orchard has not been seen by the writer up to this time, but Mr. Trine reports 77 trees as infested and 55 of them dead or nearly so, nothing but sprouts are left. The remaining 22 trees are more or less affected. In this lot the Damsons were least affected, seeming to stand the scale very well. There were a few cherry trees affected, but not seriously. Curiously enough the damage in the case just cited did not appear until the present season, and in estimating the damage caused by the scale we must deduct that done by the extremely severe winter immediately preceding the killing of the trees. It is almost certain that neither the scale nor the cold weather alone would have killed the trees, but together they made a very bad combination.

Very little if any injury was noticed before the past season, which shows that the scale had not become bad enough to kill of itself alone.

In the case of an orchard visited by the writer, about twenty plum trees were affected by the scale, the trees were mostly Lombards, with two Burbanks and one unknown variety. One tree died, to all appearances, from the scale, and four were taken out because they were about to die.

Fig. 3. European fruit-scale, *Aspidiotus ostreæformis*, on limbs of plum-tree. (Original.)

The wood of limbs two inches in diameter was distorted and dimpled where the patches of scales were found. The scales are in patches (Fig. 3), not covering the tree, and the bark is slightly discolored (darkened) wherever the scales occur. No purple stain is noticeable in the cases examined, as often occurs in the case of the San Jose scale.

In the case last cited, there was a small peach orchard joining the plum orchard, in fact it was really one orchard containing plums and peaches, and the trees were in close proximity. The peach trees had been set out for four years, yet a careful examination failed to reveal the presence of the scale. This is all the more surprising when we consider the close botanical affinity existing between the peach and the plum. In all the specimens received we have never seen a case of the scale on peach trees. It is hoped that this most luscious of fruits will continue to hold its own against the scale.

NATURAL ENEMIES.

While examining the soft maple trees referred to, several minute beetles belonging to the Coccinelidae were seen and one was captured. It proves to be *Smilia misella*, Lec.* Large patches of the skins of a Coccinelid, almost certainly *Chilocorus bivulnerus*, were noticeable. One of the adult beetles was captured among them and several were seen. Mr. Trine also noticed these patches of cast skins, some of the patches three feet long and extending half way round trees five inches in diameter.

REMEDIES.

It appears very plain that this new pest is a dangerous foe, but there are several facts in our favor. It seems to respond readily to treatment and it has not the destructive qualities and rapidity of spread exhibited by the San Jose scale. Perhaps this is due in part to the fact that it has been recognized and checked before it had an opportunity to become as widely spread as its congener, the San Jose scale.

The best remedies for this scale will no doubt be the same as those which have proven best against the San Jose scale; winter spraying with whale oil soap or kerosene emulsion, or perhaps the kerosene and water mechanically mixed. In the mechanical mixture the oil should be used at the rate of one part of oil to five of water and the application should first be made on a small scale. See page 140. In the emulsion one to six will probably prove efficient. The whale oil soap will be required at the rate of two pounds of the soap to a gallon of water, and the preparation should be applied hot. These strong sprays must be applied in the winter time to do their best work. The soap solution would do a good deal of damage if applied when the leaves were on the tree: it is likely to kill the tree outright.

All specimens of anything resembling a scale should be sent to the Entomologist of the Experiment Station at the Agricultural College, where it will receive prompt attention and the results of the examination reported to the sender as soon as possible. Many samples of scales not of much importance are received, and the knowledge of what the scale really is must prove a relief to the sender; on the other hand, if a scale like the one under discussion is present, the owner wants to know just what it is as soon as he can, in order to apply a remedy before it is too late.

DESCRIPTION OF INSECT.

(*Aspidiotus ostreæformis*, Curtis.)

Female scale irregularly rounded, conforming to the surface of twigs or other scales. Ashy-grey in color. Exuviae often orange, sometimes brown, in color; covered with a crust of secretion; first cast-skin often showing through crust and second invisible unless crust is broken. Crust light in color and translucent. Size 1½ to 2 mm.

Male scale darker in color and smaller, ½ the size of the female. Cast-skin raised and more or less flat. Often a slight raised rim around outer edge; central nipple present. The color is black or brown and the rim around the cast-skin and the central nipple are often whitened.

The characters of the pygidium or terminal segment of the female are as follows: One pair of well developed lobes beside one or two pairs of poorly developed or even

* This beetle was kindly determined for me by Mr. Schwarz through the kindness of Dr. L. O. Howard, Department of Agriculture, Washington, D. C.

rudimentary lobes; median lobes broad, rounded, with a deep notch at about one-third the distance from the distal margin. Laterad of the median lobes are two pairs of incisions in the body wall with thickened edges, and laterad of each of these is a rudimentary lobe.

There are a pair of inconspicuous, simple plates between the median lobes, also a pair of broad, short, simple plates caudad of each of the incisions. Sometimes these plates opposite second incision are serrate on outer side, there being five or six teeth on a plate.

The spines are situated as follows: One pair on lateral margin of median lobes, one pair between first and second incisions, one pair laterad of second incision, one pair half way from median lobe to penultimate segment and one spine about one-fifth the distance from penultimate segment to median lobes.

There are five groups of spinnerets. Posterior laterals, 6-10; Anterior laterals, 6-9; Anterior mesals, 1-5. Laterals in oval patches.

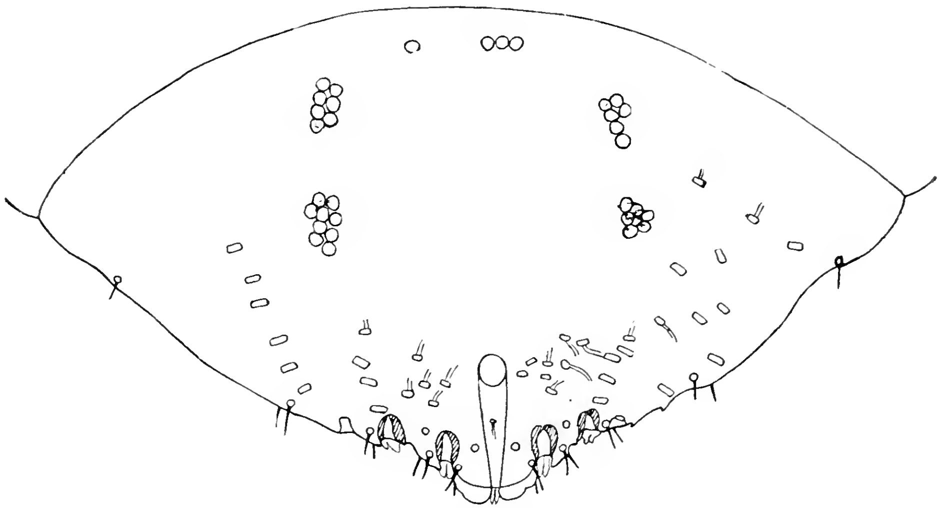


Fig. 4. European Fruit-scale, *Aspidiotus ostreæformis*, last segment of female. (Original.)

THE APPLE LEAF-MINER.

(*Tischeria malifoliella*, Clem.)

Toward the close of the past season, an examination of a great majority of the apple-trees in the vicinity of the Agricultural College would have revealed the presence of mines in the leaves. Light colored patches on either the upper or lower surfaces were not uncommon. These patches, when torn open, showed the spot to be merely a blister-like space where the soft fresh tissue of the leaf had been eaten out by a small caterpillar working between the upper and lower skins or epidermises. Such mined leaves were not uncommon in Ingham county and at South Haven they were found to be very numerous.

The larvae are said to change to the pupal condition during September, and to remain in that condition until the following May. At the time when they were examined, September 6, the larvae were in a full-grown condition, and Mr. Fulton, the Superintendent of the Sub-station, informed me that they were in a similar condition about the middle of July. This would indicate two broods a year. When made in apple leaves, the mines are irregular in form and rarely exceed three-quarters of an inch in size. The young caterpillar just from the egg, constructs a very small thread-like channel, which gradu-

ally widens out in the form of a trumpet until it becomes about as wide as long. The course of the mine is largely determined by the large veins of the leaf after this stage, and the mine often is tunneled back under the point where the original start was made. Fig. 5. These mines, as before stated, occur on either the upper or lower surfaces of the leaf.

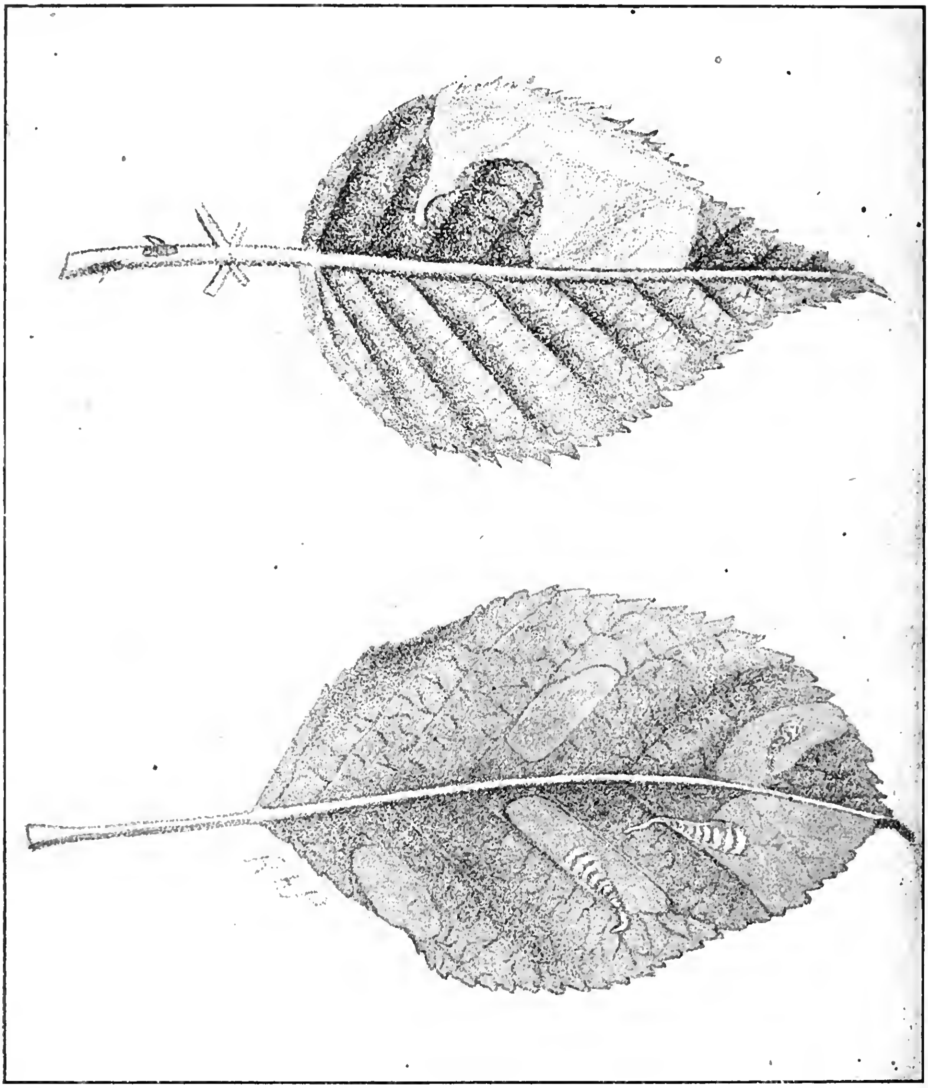


Fig. 5. Apple-Leaf-miner, *Tischeria malifoliella*, work in apple and blackberry leaves. (Original.)

The little caterpillar that builds the tunnel is about three-sixteenths of an inch in length, slender, tapering gently from near the head to a very small size at the tail, light yellowish-green in color, with a brownish black head. The legs are reduced to mere depressions in the skin. The segments are strongly marked. Fig. 6.

When the larva becomes full grown he pulls together the opposite edges of his mine until he makes a fold in the leaf, when the tiny room thus formed is lined with silk and the tranformation to the pupal stage is made. The adult which comes forth from this humble abode is a delicate little moth measuring slightly more than one-quarter

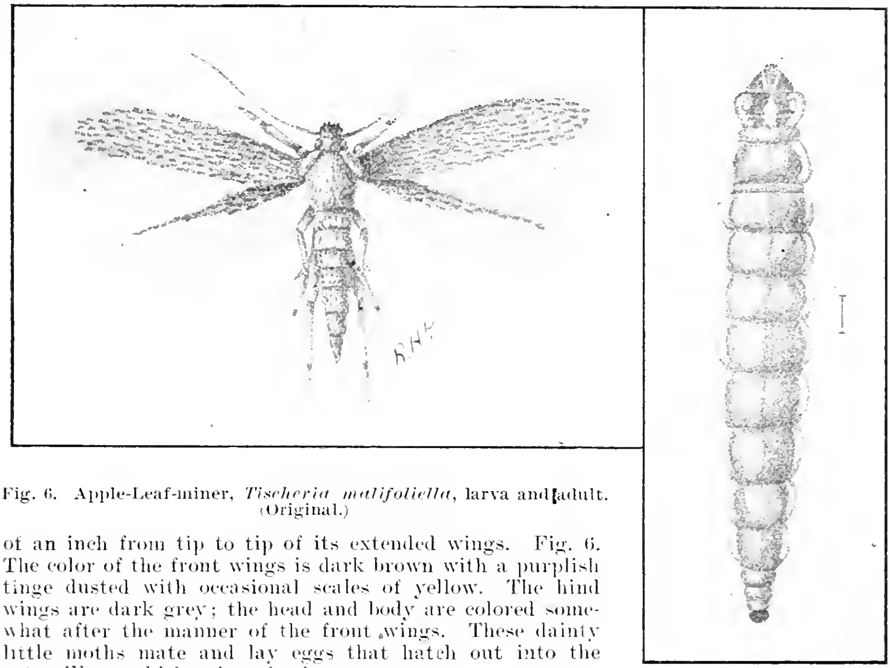


Fig. 6. Apple-Leaf-miner, *Tischeria malifoliella*, larva and adult. (Original.)

of an inch from tip to tip of its extended wings. Fig. 6. The color of the front wings is dark brown with a purplish tinge dusted with occasional scales of yellow. The hind wings are dark grey; the head and body are colored somewhat after the manner of the front wings. These dainty little moths mate and lay eggs that hatch out into the caterpillars which mine the leaves.

If the apple leaf-miner would confine its attention to the apple, and not increase its numbers more than it is in the habit of doing, no one would find fault with it, but there are other hosts on which it thrives and among them the blackberry. In working on the blackberry, the leaf miner builds a much larger mine, often using up the greater part of the leaf for this purpose. In the experimental plots at the South Haven Sub-station, the damage was quite considerable, resulting in greatly weakening the plants. The insects seem to breed in the neighboring apple trees and to come to the blackberries from there. The specimen from which the accompanying figure was drawn, was bred from a mine in blackberry on September 14, rather a late date, but no others came with it, although many mines were enclosed in the same cage. The mines of an insect—almost certainly this species—were found near by on wild running blackberry and wild crab-apple.

REMEDIES.

As the insect works inside of the leaf where no poisons will reach it, the only practical remedy is to mechanically destroy the larvae and pupae in the mines of the leaves. As stated, there are two broods, one going into the pupal stage in July, and the other in September and early October. The October brood passes the winter in the mines and emerges in the spring, usually in May. Now if we gather up the leaves just before snow falls or very early in the spring, and burn them, we shall kill all the insects contained in them. Of course the leaves under the apple trees should be gathered also and burned at the same time.

GARDEN WEB-WORM.

(*Loxostege sticticalis*, Linn.)

About the first of September, complaints were received from the vicinity of Three Rivers, Mich., of a "worm" that made a web in the sugar beet leaves. In some places, the entire crop was threatened by the ravages of these insects. Examples of these larvae or caterpillars were examined and recognized as one of the garden web-worms of which there are several species. Specimens received were about three-quarters of an inch in length, pale yellowish-green or reddish-yellow in color, with black setose spots. The head is yellowish-brown marked with brown spots; the prothoracic shield a little lighter in color: dorsum of first two segments each bearing four black spots; segments, three to eight, each bearing six black spots arranged in two triangles, one on each side; segment nine having one median large spot with two lateral smaller ones; segment ten having dorsal shield dirty yellow in color with brown spots. Under side of body somewhat lighter and marked somewhat similarly with dirty spots. Each spot is bordered indistinctly with pale. Legs pale with darker markings. Fig. 7. Specimen received August 28.

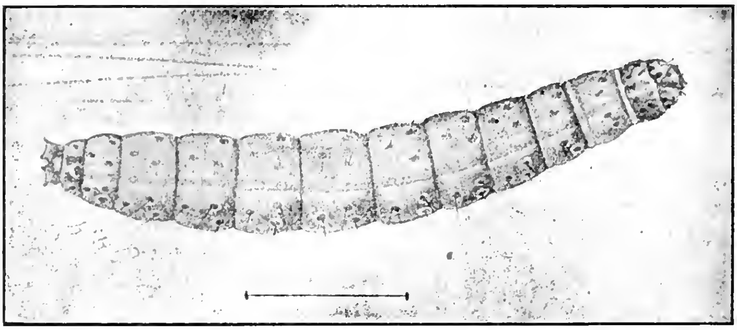


Fig. 7. Garden Web-worm, *Loxostege sticticalis*. (Original.)

On September 8 a visit was made to the place of Mr. S. M. Constantine, of Three Rivers, Mich. The field visited was about a mile out of town and was thirty-six acres in extent. The worms had been noticeable for about ten days or two weeks, working very voraciously during the dry, hot season, but not doing so much harm since the abundant rains had commenced. Nearly all the beet plants were affected and many riddled. The caterpillars work, either in a web spun about the tender leaves at the center of the plant or else on the underside of the larger leaves, where they are either protected by a slight web or without any. The holes eaten by the caterpillars are irregular in form, they vary in size, most of them being between one-fourth and one inch in diameter. In places, the tops of the beets had entirely disappeared, but the beets were easily seen by pulling aside the earth, most of them showing young sprouts ready to come forth with the first rain. The loss of foliage in this field was considerable, about three acres being entirely denuded. At the time when the field was visited, the larvae were rapidly disappearing, though a few were to be found. A quantity was collected and placed on fresh beet leaves to be reared in the laboratory. A number of adults were seen and one was captured; it was kindly determined for me by Miss Mary E. Murtfeldt, of Kirkwood, Mo. The larvae, on reaching full growth, descend into the ground and spin tubes of silk therein, where they pass the winter and emerge in the spring as winged moths, ready to propagate their kind. According to Riley and Howard,* the insect probably is two-brooded. This insect is quite troublesome in Nebraska, where it is well known.

* Insect Life. Vol. V, p. 323.

REMEDIES.

After an attack by this insect, it always is well to plow in the fall in order to expose as many of the larvae and pupae as possible.

When the larvae first appear, do not wait, but spray thoroughly with Paris green, using one pound to 175 gallons of water and adding one pound of quicklime, as explained on page 139. At Three Rivers, stronger mixtures were used, but the spraying was hardly commenced before rain set in, and it is impossible to say just what the result would have been under ordinary circumstances. In applying the poison, use a nozzle that allows of spraying upward from beneath, as many of the worms work on the under side of the leaves. Keep the leaves well poisoned as long as the worms are present and always add quicklime.

THE PALLID FLEA-BEETLE.

(*Systena taeniata* var. *blanda.*)

It has been said that no matter what plant or weed be selected, if we attempt to grow it on a large scale, insects and diseases perhaps hitherto unknown, will attack it and render its cultivation difficult. Whenever a new crop is raised. a number of our native species usually take to it, changing their food habits to that extent and sometimes making unforeseen complications. The sugar beet has had its full quota of insect enemies during the season of 1899, and not the least among them has been the Pale Flea-beetle.

This insect is so small that it seems almost impossible for it to do any serious harm, but it occurs in great numbers, at times swarming over the beet plants. It measures about one-eighth of an inch in length and is yellowish-brown in color. Down each wing-cover extends a yellow stripe. The prothorax is yellow and the head brownish-red The legs are yellowish-brown with the hind thighs swollen, and the underside of the body is black. Fig. 8. The name flea-beetle is given to this group of beetles because of their habit of jumping like fleas when disturbed.

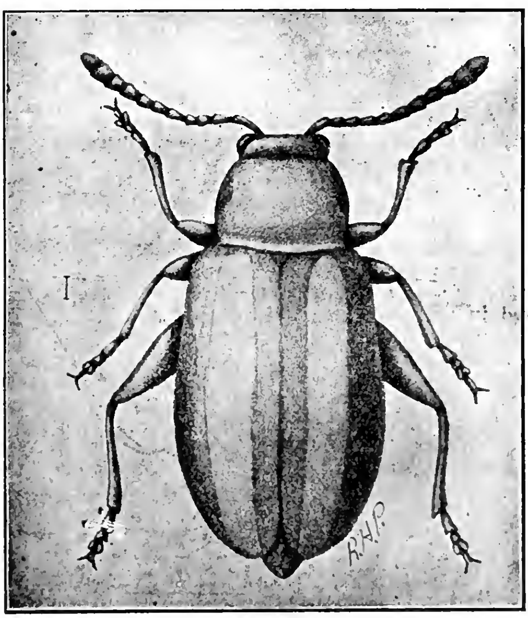


Fig. 8. Pallid Flea-beetle, *Systena taeniata* var. *blanda*. (Original.)

While this beetle was probably to be found sparingly distributed over the State, most of the complaints came from two regions: first, the region about Benton Harbor, both to the north and south: and second, about Bay City. They were first noticed about the middle of June and continued in evidence for several weeks.

At the request of Mr. H. C. Rockwell, Secretary of the Wolverine Beet Sugar Co., one or two fields in the vicinity of Buchanan were visited. The beets were, at that time, from one-half inch to six inches tall, and healthy in appearance except for the attacks of this beetle and the effect of a long drought, the soil in these fields being sandy. The farms of Mr. Chas. Pears and Mr. Chas. Bishop were visited. The insects seemed to prefer the low places, completely denuding areas one-half acre in extent, and nearly ruining the rest. On Mr. Pears' place the loss was estimated at 50 per cent: this was the most severely damaged place seen. The beetle was here found to be associated with another flea-beetle, blue in color and larger, know as the triangle flea-beetle (*Disonycha triangularis*).

Beside beets, the beetle was found working on potato, sorrel, and pigweed, and appeared also to be working on smartweed and corn. It is said to love ragweed especially and also lamb's-quarter (*Chenopodium*), purslane and white clover, as well as some members of the mustard family. No doubt it works on other plants.

On the 27th of June, a visit was made to the farm of Mr. Geo. Ziegler of Bay City, at the request of Hon. Eugene Fifield, of that place. In company with Mr. Fifield, the place was visited, and several sprays applied by way of experiment. The work of the beetles about Bay City was much the same as that about Benton Harbor, except that it was not so bad and was more patchy in character.

The effect of a large number of these beetles is easily seen, the young plants are browned and withered; on examination, they show that the surface of the leaf, either the upper or the lower surface, is eaten out in patches, leaving the remainder to dry up and fall out, showing at last only a ragged hole.

The life history of this interesting insect has not yet been recorded. It is known that the larva is a small, slender, worm-like insect which feeds on the roots of certain plants, probably largely on weeds. Clean culture, from this fact, is clearly indicated.

All the severe injury, thus far, has been during dry weather, and it is hoped that in an ordinary season, the damage will be greatly reduced. Fortunately the danger from it is confined largely to the early part of the season, while the plants are young, and at this time it is not too late to re-seed if absolutely necessary.

REMEDIES.

A number of attempts were made to apply sprays for the purpose of proving their efficacy, but ill luck attended every effort. The writer would start out, with a clear sky overhead and every appearance of continued settled weather, and advise several test sprays, or if possible apply them himself, when the sky would immediately cloud over and rain fall, sometimes for several days, washing off all the poison and sometimes drowning the insects; but what is more important, leaving us without the information sought. Owing to this state of affairs, it became necessary to draw on the results obtained in other states.

In response to a letter addressed to Prof. Lawrence Bruner, of Nebraska State University, who has worked many years on sugar beet insects, the following reply was received, in part: "In reply I would state that we have had very little experience in fighting the pale flea-beetle (*Systena taeniata* var. *blanda*). Several years ago, this insect appeared in rather large numbers on sugar beets early in the year and was handled at that time by the use of both kerosene emulsion and Paris green sprays. Of the two, Paris green seemed to be by far the more successful, though this insect seldom appears except for a week during the time when the beets are quite small."

From the foregoing it will be seen that the beetle is not a regular visitor in Nebraska and possibly may prove not to be here. It thrives best in hot, dry weather and early in the season. When it appears, the best course to pursue, until further experience has taught us better, is to spray with Paris green, using one pound to one hundred and seventy-five gallons of water and adding one pound of quicklime. See directions for mixing on page 139.

THE TRIANGLE FLEA-BEETLE.

(*Disonycha triangularis*, Say.)

Another beetle which works something like the pallid flea-beetle is the triangle flea-beetle, so named on account of three spots arranged in the form of a triangle on the prothorax. This little fellow varies from three-sixteenth to one-quarter of an inch in size. It is blue-black in color with an orange prothorax, on which the three dots are arranged as before mentioned. Fig. 9.

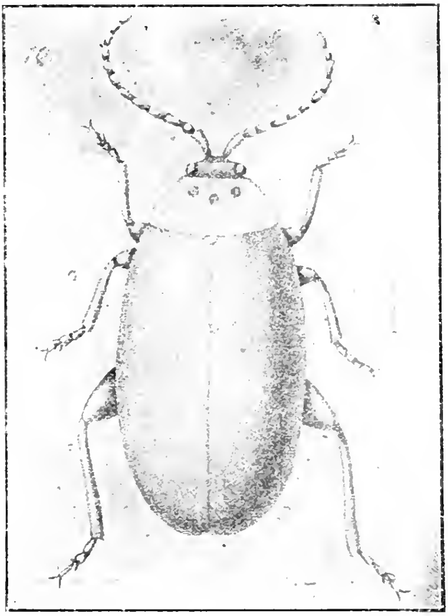


Fig. 9. Triangle Flea-beetle, *Disonycha triangularis*. (Original.)

The damage from this insect was comparatively slight. It occurred with the pallid flea-beetle, but its numbers were far from being so great. It was quite plentiful at Buchanan, and no doubt did a great deal toward bringing about the general trouble at that place.

REMEDIES.

This insect should be treated the same as the pallid flea-beetle.

BLISTER BEETLES.

Throughout the region from Saginaw Bay, southwest across the State to the lower end of Lake Michigan, or in other words, throughout the old Saginaw Valley, there has been trouble with the blister beetles. This attack by blister-beetles, however, is to be expected, being only a repetition of what has taken place in other states when the raising of sugar-beets in quantity was commenced. Like several other insects the blister-beetles were satisfied with the food provided by nature, until the advent of the beet. True they did occasionally levy a tax on potatoes, but they dearly love the wild

vetches and almost any plant of the pea or bean family, and as there usually is plenty of available food of this and other sorts, they remained here unnoticed, occasionally appearing in numbers on alsike, etc.

With the advent of the sugar beet, the blister beetles were provided with another source of food very much to their taste, and one which they seemed to prefer to most others. As a rule, the blister beetles appear during the latter half of July and become numerous during August and September, devouring the leaves and often doing considerable damage.

All this looks very bad, but when we inquire into the early history of the insect, we find a very good record which helps us materially to forgive a part of the latter depredation. The young blister beetle of the varieties noticed here, passes his larval stage in the egg-pod of one of the grasshoppers, devouring usually from 30 to 40 eggs, after which he burrows a short distance into the ground, passes through the pupal stage, and comes out ready to collect pay of the farmer.

All the common blister beetles of this region, except the steel-blue one (*Meloe*), have this beneficial habit, so when we see a blister beetle eating our crops, we may be certain that he represents from 25 to 40 grasshoppers, literally nipped in the bud. This fact should have its influence in considering the insect, and so long as the number of the beetles is small, and the crop does not appear to be suffering, it is perhaps well to forbear destroying them. However, should they become numerous, and should there seem to be danger of damage, the best course is to remove them with a spray.

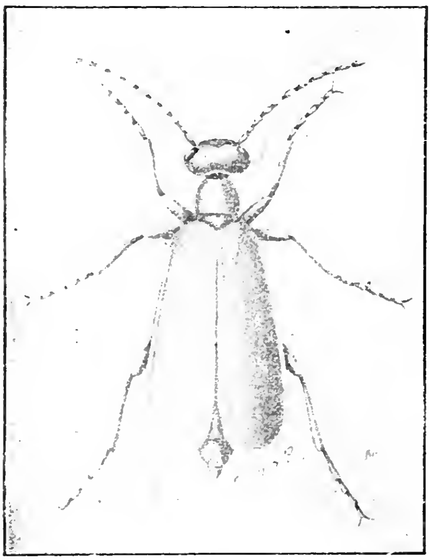


Fig. 10. Blister beetle, *Epicauta cinerea*. (Original.)

There are three varieties which have been reported as injurious during the season of 1899,—*Epicauta cinera*, Fig. 10, and its variety *concolor*, and *E. pennsylvanica*. The last named species is the one found so abundantly in the early fall in the heads of golden-rod.

REMEDIES.

When the danger of real injury becomes apparent, there is usually little difficulty in ridding the plants by a spray of Paris green and lime, applied at the rate of one pound of the poison to 175 gallons of water. Often the beetles will keep coming in from the outside, and when the first spray has lost its effect from rain, or other cause, it may be necessary to repeat the treatment.

OTHER SUGAR BEET INSECTS.

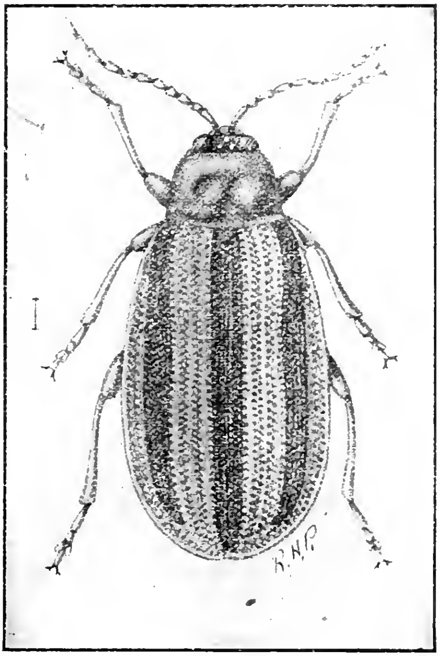


Fig. 11. Cucumber beetle, *Diabrotica vittata*. (Original.)

The cucumber beetle (*Diabrotica vittata*) Fig. 11. This well known insect was sent to us on one occasion from the western part of the State, together with a number of flea-beetles, as infesting the sugar beet. It has not been found by us or reported as injurious to any great extent.

The large-eyed ground-bug (*Geocoris bullata*) was sent to us as having been found on sugar beets. It is mentioned by Professor Lawrence Bruner, of Nebraska, as occurring under the same conditions.

The tarnished plant-bug (*Lygus pratensis*), *Agallia sanguincolenta*, Prov.,* and *Phlepsius irroratus*, Say.,* were collected at Buchanan on the beets. Prof. Herbert Osborn says, in a letter, "The Agallia has been recorded on sugar beets two or three times and may be troublesome."

It is probable that the insects of this last sort will not ever multiply so as to become very dangerous pests. The cleanest of clean culture, which sugar beets should have in order to get the best results, is bound to be of use against them, as they feed on weeds in nature, and if the weeds are removed in the field and along fences, waste places, etc., and all such places are kept cultivated, these natural feeding and breeding grounds will be destroyed and the insects will be kept in check.

The yellow bear (*Spilosoma virginica*). Several larvae of this species were found in the beet field at Three Rivers. It is one of the common garden caterpillars, not ordinarily dangerous and readily controlled by a spray of Paris green.

* These two insects were kindly determined by Prof. Herbert Osborn of the Ohio State University.

STRAWBERRY ROOT-BORER.

(*Typophorus canellus*, Fab.)

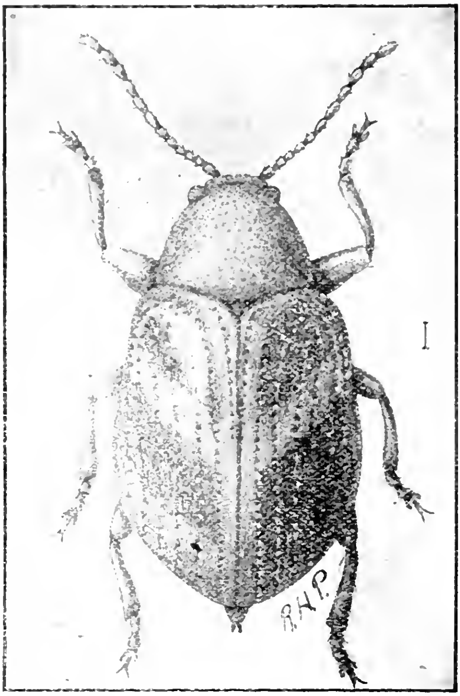


Fig. 12. Strawberry Root-borer. *Typophorus canellus*, adult beetle. (Original.)

An insect, by no means new to Michigan, but which nevertheless is little known, is the strawberry root-borer. Prof. Cook mentions it as occurring at Lansing, in 1880, at which time it was quite a serious pest. During the past summer it has made its presence known in quite an emphatic manner in the southwestern part of the State.

The full-grown beetle is yellowish-brown in color with ordinarily four black spots upon the wing-covers. These spots vary a good deal in size and form. The prothorax and head are colored reddish-brown. The entire insect is highly polished and the wing covers are ornamented with longitudinal rows of minute pits. the beetle being about one-eighth of an inch in length. Fig. 12. The larva or grub is about the same size when fully grown: it resembles a white grub such as is found under sod, except in size. Fig. 13. It is sometimes found in numbers an inch or so beneath the surface of the ground, feeding on the strawberry roots. When the time comes for it to change to the pupal form, it makes a little smooth-walled cell in the soil, where it undergoes its transformations.

The life history is about as follows: The insects pass the winter as adults. They have been collected hibernating under rubbish near the edge of wooded land.* The adults appear in March, according to Prof. A. J. Cook: they appear in numbers during the first part of May. Eggs are laid and the larvae work on the roots while the adults continue to eat holes in the leaves of the plants until after the fruit is picked, about which time they usually disappear. They again become numerous in August and September, according to Dr. Lintner.

* Schwarz, Insect Life, Vol. V, p. 336.

The injury from these little fellows is at times very serious. On May 6th of the past summer, specimens were sent us by Mr. S. H. Fulton, foreman of the South Haven Fruit Station, with the complaint that they were eating holes in the leaves of the plants at that place, threatening the crop in the case of some varieties. On October 10th, specimens of what will probably prove to be *Scelodonta pubescens* from northern Indiana were sent us by Mr. R. M. Kellogg of Three Rivers. This is a closely allied species which works almost the same as the species under consideration. They had constructed small cells of earth and apparently were ready for cold weather. Mr. Kellogg reported that they, together with a root-louse, were killing many plants.

Fig. 13. Strawberry Root-borer, *Typophorous canellus*, larva. (Original.)

REMEDIES.

Whenever the adult beetle is present and the plants are not in bloom, no sets or fruit being present, they may easily be destroyed by a spray of Paris green. Mr. Fulton used three ounces of poison to 40 gallons of Bordeaux as advised, and reports the finding of only two beetles afterward. The result is just as good if water is used instead of Bordeaux, provided lime is added. See directions. When the fruit is set, kerosene-emulsion must be substituted for the Paris green, as the poison is very dangerous when applied to a fruit which ripens as quickly as the strawberry. It is almost certain that the use of commercial fertilizers or tobacco dust would prove useful. Of course it would be folly to use infested ground for the purpose of setting out new plants. Wait until the insects are starved out and do not grow strawberries very near the old infested patch.

For the larvae of the *Scelodonta pubescens*, late fall plowing or early spring plowing will bury many of them so deeply that they will never come out.

THE BUMBLE FLOWER BEETLE.

(*Euphoria inda.*)

During the first warm, sunny days of spring, it is not uncommon to see numbers of clumsy beetles flying swiftly about in circles over a clear space of grass or lawn. The flight is rapid and accompanied by a loud humming noise, not unlike that of a bumble-bee. Often, if closely watched, it will be found that one is chased by a fly a little larger than a house fly. (A species of Tachinid which is parasitic, and which is

attempting to deposit its eggs on the beetle.) On knocking down one of these beetles, we will find it to be a little more than half an inch long and yellowish-brown in color, spotted with black, and having coppery reflections. Fig. 14. The beetles disappear shortly after laying their eggs and are not seen until the following fall, when they again appear, usually in greater numbers, and attack green corn, ripening fruit, etc., in fact anything having a sweet sap. They sometimes cluster in numbers on fresh wounds of trees and used to be a nuisance when fruit and corn were dried in the old way, by spreading it out in the sun. They not infrequently penetrate clear to the pit of a ripening peach and entirely destroy the fruit. Often they get into the ears of sweet corn and render quantities unfit for the market.

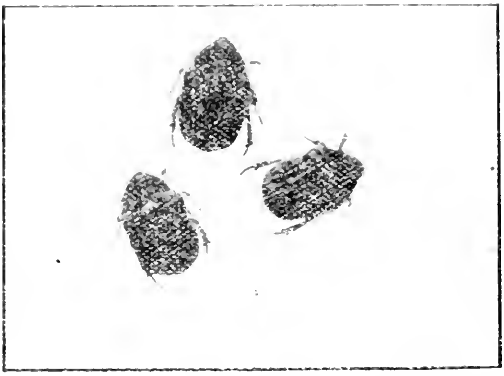


Fig. 14. Bumble Flower-beetle, *Euphoria inda*. (Original.)

During the past season, very many complaints have been made to the discredit of this beetle. The very nature and condition of the fruit on which these insects are found, renders it impossible to use poisons.

The only manner of fighting them consists in collecting the insects when clustered on fruit or wounds of trees, and this usually is not practical unless the fruit is grown on a very small scale. It is a comfort to know, however, that this insect does not very often occur in sufficient numbers to do much damage.

RED RASPBERRY SAW-FLY.

(*Selandria rubi*, Harris.)

The red raspberry saw-fly is an old offender from whom we expect to hear periodically. Last year it made its appearance known in the southwestern part of the State, and became very bad in restricted localities. At Benton Harbor, quite a destrict was infested, and, in certain fields visited, the damage was very serious indeed. The false-caterpillar that does the damage is a delicate green "worm" about three-quarters of an inch long and covered with pretty, green spines. They occur in great armies and sometimes, as in the case cited, almost cover the canes, eating holes in the leaves until they resemble loose sieves.

The life history of the insect is substantially as follows: The eggs are laid under the skin of the leaf, not far from some of the large ribs, during the latter half of May. The larvae that come from them are at first white, but afterward become the color of the leaf. They are covered with transverse rows of divided spines. The color of the head is yellowish-green with a dark spot on each side. The "worms" are not easily seen until their work becomes apparent; they eat the soft parts from between the ribs, leaving sometimes a mere skeleton.

When the larvae become full grown, which takes about a month from the laying of the eggs, they descend and burrow into the ground and spin a firm cocoon composed of silk and bits of earth; in this they change to pupae and emerge the following spring as adult saw-flies.

REMEDIES.

Most saw-flies are comparatively easy to kill if it possible to get at them. In this case the larvae readily succumb to most of the poisons, but unfortunately they come out during the time when the fruit is on the canes and it is impossible to use arsenicals. Dr. Saunders recommends hellebore applied in the form of a spray, using one ounce to a pailful of water. This can be used on the plants early in the season if the fruit is just set, but after the fruit is well set it is unsafe. A good spray of kerosene emulsion has been found very useful, but in using this it must be remembered that each worm must be hit to be killed, and the plants are not protected against the great numbers that constantly are being hatched from the eggs. These will require a repetition of the treatment, sometimes several repetitions. A strong solution ot soft soap has been used successfully when applied very thoroughly.

CARPENTER BEES.

While examining the fields of red raspberries infested with the saw-fly, many of the canes, cut off the year before, were found to have tunnels in the pith for a distance of from one to six inches. These round tunnels were about one-eighth ot an inch in diameter and very smooth and even. One was split down the side with a penknife and found to be tunneled by a small wasp (*Xylocrabro stirpicola*), Pack.* one of the adults emerging as the cane was cut. Another species (*Ceratina dupla*), Say,* was bred from the tunneled stems. Fig. 15. The life history of these insects is very inter-

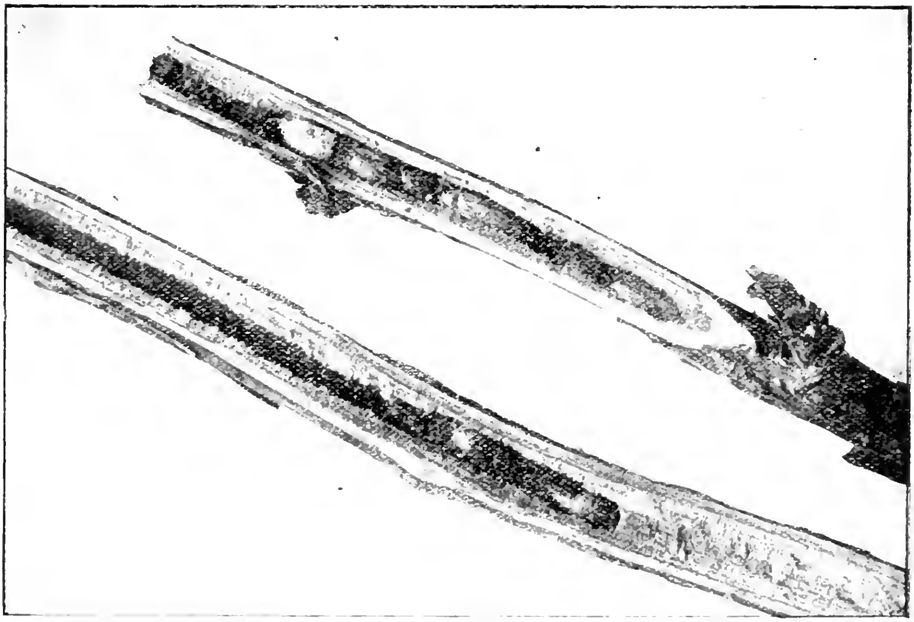


Fig. 15. Tunnels of Carpenter-bees in Red-raspberry. (Original.)

esting. The mother cuts out one of these holes, and after storing food in it, lays an egg, and then places a partition over food and egg, making a small room. This process is repeated, making a series of chambers or spaces, each with its egg and stored food. The eggs hatch and the young grubs feed on the stored food, in time spinning cocoons and turning into winged wasp-like insects themselves.

* These two insects were kindly determined for me by Mr. Ashmead through the kindness of Dr. L. O. Howard of the Department of Agriculture, Washington, D. C.

It is not very likely that these insects will prove injurious, as they seem to confine themselves to the cut-back canes which are just through bearing, and which, in well regulated fields, would be removed before the next year. No cases were seen where the new growth was attacked. In case this insect ever should become troublesome, it can easily be kept in check by pruning.

FORMULAS AND DIRECTIONS FOR USE OF INSECTICIDES.*

PARIS GREEN.

At the head of all the stomach poisons stands Paris green or arsenite of copper. To prepare Paris green for spraying, slake one pound of well-burned quick lime in hot water and stir in one pound of Paris green. Allow this mixture to stand over night, strain, and then stir it into from 150 to 250 gallons of water. Keep the liquid well stirred while spraying. For most insects, one pound to 200 gallons of water is sufficient, and at this rate it will not injure the plant. Stone fruits, such as peach, plum and cherry, should not receive a spray much stronger than this, but apples, pears, etc., may be sprayed with a mixture considerably stronger, viz., one pound to 150 gallons of water. Potatoes may be sprayed with one pound to 100 gallons of water. Paris green is fairly uniform in composition if not adulterated, and is perhaps the safest and surest remedy for chewing insects as a whole.

DRY METHOD.

While ordinarily it is most economical to use Paris green in the form of a spray, in some instances, where only a few plants are to be treated or where no pump is available, it is expedient to use it as a dry powder. It should then be mixed at the rate of one pound of the poison to 100 pounds of plaster, flour, or air-slaked lime, and dusted on the plants through a sack of burlaps or some loose, coarse cloth. It is best to make the application in the morning when the dew is on the plants. Never apply dry poisons where the wind can blow the powder into pastures or places where cattle or horses are feeding.

THE KEDZIE MIXTURE (ARSENICAL).

An arsenical spray which has the advantage of being very cheap and uniform, as well as effective, is the Kedzie mixture, so named because it was originated by Dr. Kedzie of the Agricultural College. In these days of adulterated Paris green, a uniform spraying mixture is highly appreciated. Dr. Kedzie, in giving directions for its preparation, says: "Dissolve the arsenic by boiling with carbonate of soda, and thus insure complete solution: which solution can be kept ready to make a spraying solution whenever needed. To make the material for eight hundred (800) gallons of spraying mixture, boil two pounds of white arsenic with eight (8) pounds of sal-soda (crystals of carbonate of soda—'washing soda'—found in every grocery and drug shop) in two gallons of water. Boil these materials in any iron pot not used for other purposes. Boil for fifteen minutes or until the arsenic dissolves, leaving only a small muddy sediment. Put this solution into a two-gallon jug and label 'Poison,' stock material for spraying mixture.

"The spraying mixture can be prepared whenever required, and in the quantity needed at the time by slaking two pounds of lime, adding this to forty gallons of water; pour into this a pint of the stock arsenic solution. Mix by stirring thoroughly, and the spraying mixture is ready for use. The arsenic in this mixture is equivalent to four ounces of Paris green."

Cost for 800 gallons spraying mixture:

2 pounds white arsenic	$0 25
8 pounds sal-soda	25
40 pounds lime	70
Total	$1 20

* For further directions and formulas for spraying see Bulletin 160 or Bulletin 175 of this department.

"The pot, jug, etc., must never be used for any other purpose after using it for making this mixture."

If an additional pound or two of lime be added to the mixture it will help to make the application permanent and conspicuous without in any way interfering with its effect. In using it the extra lime is often added.

CONTACT INSECTICIDES FOR INSECTS WHICH SUCK THEIR FOOD.

The most effective contact insecticides are kerosene emulsion and whale-oil soap. Kerosene emulsion may be used against all lice (except bark lice), bugs, etc., which do not succumb to the internal poisons. To be effective it must be very carefully made and conscientiously applied.

Place two gallons of ordinary kerosene in a warm place, either in a warm room or in the sun, and allow it to become as warm as possible without danger from fire. Boil one pound of laundry soap or whale-oil soap in a gallon of soft water until completely dissolved. If the water is the least bit hard, "break" it with washing soda. Remove the soap solution from the fire, and while still boiling hot add the kerosene and agitate for ten minues, or until the oil is emulsified, with a spraying pump, by forcing the liquid back into the vessel from which it was pumped.

When the liquid is perfectly emulsified it will appear creamy in color and will flow evenly down the side of the vessel. Care should be taken to completely emulsify the oil, and this is accomplished much more easily when the mixture is hot. This strong emulsion may now readily be diluted with water and used, or it may be stored away for future use. When cold it becomes like sour milk in appearance, and should be dissolved in three or four times its bulk of hot water before diluting with cold water.

Small amounts of this emulsion may be made by using the ingredients in small quantities, but in the same relative proportion.

It should be diluted ten times for most insects, but many plants are able to resist a stronger mixture, which is usually more effective.

KEROSENE AND WATER.

Kerosene and water applied with a special pump, designed for the purpose, has sometimes been substituted for kerosene emulsion, when a large amount of work is to be done in the winter time against scale insects. This method of spraying would have obvious advantages if it were entirely safe. Very contradictory results have been obtained with this spray, and if anyone intends to use it, let him proceed with due caution and apply it in a small way several times before using it at all extensively. This application never should be made except on a bright sunshiny day, when the evaporation is rapid, otherwise the oil will strike into the tree and kill it. The oil used should be quite a high test oil as well.

A pump suitable for applying this mixture takes the oil from one tank and the water from another, mixing them as they pass through the pump and nozzle, and furnishing a spray that resembles ordinary emulsion, milky in appearance, but which does not remain for so long a time in combination. The oil soon collects and rises from the water, and for this reason it is more dangerous on any but sunshiny days, when it will evaporate quickly after being applied. Great care must be taken that the pump is doing its duty and that it does not produce a varying spray. This should be tested from time to time by catching some of the spray and putting it in a tall glass to let the oil and the water separate.

The application should not be made with more than 20 per cent of oil or one part of oil to five of water, and the writer would discourage the use of this mixture on the peach until we know more of its behavior.

Prof. V. H. Lowe, entomologist of the New York Agricultural Experiment Station at Geneva, New York, writes me that his experiments have led him to believe the use of this mixture to be yet in an experimental stage, and that his results have been very conflicting and at times fatal to the tree.

The results here have been more encouraging, though the experiments have not been extensive enough to base much faith on them.

CO-OPERATIVE SOIL TEST EXPERIMENTS.

BY J. D. TOWAR.

Bulletin 181.—Agricultural Department.

Following the plan suggested by Prof. Atwater, on pages 24 to 28 of Circular No. 7, Office of Experiment Stations, on "Co-operative Experiments with Fertilizers," the department began a series of soil test experiments in the spring of 1899. The offer to conduct a limited number of these experiments was made by the department and published in the M. A. C. Record, from which it was copied by several other newspapers in the State. A great many more farmers than could be accommodated accepted the offer, thereby giving us a large area of the State for selection of localities. The places selected for conducting the experiments were decided upon as to their geographical distribution in the State, proximity to the railroad, and general location for making a convenient route in visiting the various places. The department was generally fortunate in the selection of men and places for this work. In every case where the experiment was under the direct charge of the man owning the farm perfect satisfaction and a carefully conducted experiment was the result. A few unforeseen calamities, and in some cases unfortunate selection of ground for the experiment, rendered valueless some of the results obtained.

The crops sown, unless for some particular reason it became necessary to make a change, were corn, potatoes, field beans and sugar beets. The plots were usually laid out in a way that the whole would occupy nearly a square area, thus making the twelve or thirteen plots about ten or twelve times as long as they were wide. This afforded convenient areas of each crop by sowing the seed in rows crosswise of fertilized plots. In general, the arrangement of plots and the amount of fertilizer applied were as follows:

Arrangement of plot in soil test experiment and amount of fertilizers applied per plot of 1-10 acre each:

Plot 1, no fertilizer.
Plot 2, 12 pounds nitrate of soda.
Plot 3, 24 pounds dissolved phosphate rock.
Plot 4, 12 pounds muriate of potash.
Plot 5, no fertilizer.
Plot 6, 12 pounds of nitrate of soda, 24 pounds dissolved phosphate rock.
Plot 7, 12 pounds nitrate of soda, 12 pounds muriate of potash.
Plot 8, 24 pounds dissolved phosphate rock, 12 pounds muriate of potash.
Plot 9, no fertilizer.
Plot 10, 12 pounds nitrate of soda, 24 pounds dissolved phosphate rock, 12 pounds muriate of potash.
Plot 11, 48 pounds commercial fertilizer.
Plot 12, 2 loads stable manure.
Plot 13, no fertilizer.

A space of three feet was left unfertilized between the plots, though this ground was planted the same as the fertilized areas. The nitrate of soda used in this experiment contained 18.7 per cent ammonia. The dissolved phosphate rock, 15.85 per cent available phosphoric acid, and 1.82 per cent insoluble, making total phosphoric acid 17.67 per cent. The muriate of potash contained 49.85 per cent potassium oxide. The commercial fertilizer used was a wheat and corn fertilizer offered by a leading manufacturer, but, unfortunately, we have not the exact analysis of this material. It will be seen by the above that plots 2, 3 and 4 were devoted to the single elements—nitrogen, phosphoric acid and potash; plots 6, 7 and 8, to combinations of two of these elements, while plot 10 combined all three of the essential elements of plant food.

Below is a list of the names of the men who conducted these experiments, with the counties and postoffice addresses:

Parmelee farm, Meridian, Ingham county, light sandy soil, reduced to a considerable degree of exhaustion.

E. C. Reed, Howell, Livingston county, very light sandy soil, poor.

L. B. Walton, Dryden, Lapeer county, clay loam, soil severely reduced by continuous cropping.

J. Y. Clark, Orion, Oakland county, clay loam, slightly rolling, somewhat uneven.

Bruce Phillips, Utica, Macomb county, level, uniform sandy soil.

G. C. Lawrence, Ypsilanti, Washtenaw county, sandy loam, poor soil, light and rolling.

L. L. Thompson, Kalamazoo, Kalamazoo county, sandy loam, very much exhausted, rolling.

H. M. Kingsley, Kendall, Van Buren county, sandy loam, a portion of the field received drainage from the barnyard.

H. D. Weatherwax, Jenison, Ottawa county, sandy soil, experiment abandoned.

T. P. Steadman, Manistee, Manistee county, light sandy soil, experiment abandoned.

O. C. Wheeler, Belding, Ionia county, loam.

C. E. Mills, Mancelona, Antrim county, medium loam, ground somewhat rolling.

L. R. Williams, Otsego Lake, Otsego county, light sandy soil.

A. E. Gregory, Dowagiac (experiment conducted in Van Buren county), sandy loam, level and uniform.

Agricultural College farm, Agricultural College, Ingham county, loam.

PARMELEE EXPERIMENT FARM—INGHAM COUNTY.

The Parmelee farm is an example of severe cropping and injudicious "running" that is seldom seen in central Michigan. The soil is naturally a very light sand which suffers severely during the summer droughts. The humus is entirely exhausted, while the open, sandy condition of the soil has encouraged complete waste and leaching of the elements of fertility. Throughout the early growth of the crops there was a manifestly greater development on the plots receiving nitrogenous fertilizers, but the dry weather so completely burned the soil and crops that the final yield in no way indicates the needs of this soil. The experiment is being continued with the hope of more satisfactory results.

L. R. WILLIAMS EXPERIMENT—OTSEGO COUNTY.

	Fertilizers per acre.	Pounds.	Yields per acre.			
			Beans. Lbs.	Beets. Lbs.	Corn. Lbs.	Potatoes. Lbs.
1	Nitrate of soda	120	880	3,280	680	8,640
2	Dissolved phosphate rock	240	760	4,040	720	7,720
3	Muriate of potash	120	840	4,480	1,160	6,080
4	No fertilizer		840	3,520	1,600	6,800
5	Nitrate of soda Dissolved phosphate rock	120 240	800	5,040	1,760	8,280
6	Nitrate of soda Muriate of potash	120 120	1,120	5,480	1,360	9,800
7	Dissolved phosphate rock Muriate of potash	240 120	960	6,520	1,400	9,160
8	No fertilizer		1,000	6,040	1,600	5,120
9	Nitrate of soda Dissolved phosphate rock Muriate of potash	120 240 120	1,000	7,840	1,840	5,480
10	Stable Manure (20 loads)		1,160	8,080	2,440	7,320
11	Commercial fertilizer	480	1,160	8,640	2,040	7,600
12	No fertilizer		1,280	8,240	2,240	7,240

The writer did not visit this field. The uniformity of the results and the very slight benefit arising from the application of liberal amounts of commercial fertilizers suggests the same difficulty that is apparent in connection with many of the other fertilizer experiments conducted during this season. In order that any plant food may become useful to a growing crop there must be a sufficient amount of rainfall

to dissolve the elements of plant food that are present. It is quite probable that the crops in this experiment starved in the presence of an abundance of food simply because of a lack of water. The same fertilizers with a sufficient supply of rain might, and probably would, have given very different results. Certainly in this soil such applications of fertilizers as were made here, ought to increase the yield over plots where none was applied.

THE E. C. REED EXPERIMENT—LIVINGSTON COUNTY.

	Fertilizers applied per acre.	Pounds.	Yields per acre. Threshed beans. Lbs.	Potatoes. Lbs.	Corn. Lbs.
1	No fertilizer		1,800	1,400	300
2	Nitrate of soda	120	2,080	1,800	820
3	Dissolved phosphate rock	240	960	1,680	1,100
4	Muriate of potash	120	920	2,200	1,450
5	No fertilizer		720	2,160	1,600
6	Nitrate of soda Dissolved phosphate rock	120 240	800	1,600	880
7	Nitrate of soda Muriate of potash	120 120	680	1,680	200
8	Dissolved phosphate rock Muriate of potash	240 120	800	2,000	140
9	Nitrate of soda Dissolved phosphate rock Muriate of potash	120 240 120	880	2,040	260
10	Commercial fertilizer	480	1,280	2,280	280
11	Stable manure (20 loads)		1,000	2,400	540
12	No fertilizer		1,200	1,400	280

Sugar beet seed was sown on this field, but the cut worms destroyed the first sowing and dry weather killed the second. The soil is light and rolling and readily blown by the wind. The trial was very unsatisfactory and in no way indicated the needs of this soil.

L. B. WALTON EXPERIMENT—LAPEER COUNTY.

Mr. Walton's land lies nicely for experimental work, it being a smooth tract sloping but slightly to the north. Mr. Walton's farm has undergone severe cropping for a number of years, though it is made up of that heavy loam soil that usually produces profitable crops.

As will be seen by the following table, Mr. Walton added a few plots to the experiment as originally planned. Plots 10 and 14 received the same fertilizers, with the addition of a ton of air slaked lime to the acre on 14. The treatment of the other plots is indicated by the following table:

	Fertilizers per acre.	Pounds.	Yields per acre.			
			Beans. Lbs.	Beets. Lbs.	Corn.	
					Hard. Lbs.	Soft. Lbs.
1	No fertilizer		1,020	4,960	860	1,540
2	Nitrate of soda	120	1,230	7,860	280	1,300
3	Dissolved phosphate rock	240	880	9,740	420	1,460
4	Muriate of potash	120	640	5,640	460	1,240
5	No fertilizer		780	6,600	420	1,310
6	Nitrate of soda Dissolved phosphate rock	120 240	860	9,540	500	1,300
7	Nitrate of soda Muriate of potash	120 120	1,230	8,280	220	930
8	Dissolved phosphate rock Muriate of potash	240 120	900	8,580	300	940
9	No fertilizer		870	6,720	900	1,320
10	Nitrate of soda Muriate of potash Dissolved phosphate rock	120 120 240	800	11,880	1,360	1,200
11	Stable manure (20 loads)		1,080	12,620	1,060	1,240
12	Commercial fertilizer	480	680	10,480	790	1,100
13	No fertilizer		800	5,780	560	1,080
14	Complete fertilizer (duplicate of plot 10) Air slaked lime	 2,000	880	9,080	850	1,040
15	Air slaked lime	1,500	960	8,440	970	1,240
16	Hardwood ashes	1,500	900	10,080	1,170	1,380
17	Air slaked lime Hardwood ashes Salt	1,500 1,500 1,500	840	14,120	1,060	1,280

Plot 1 was at the end of the field where the horses turned in cultivating, and included the head-land made in plowing. This condition in all probability affected the yield on the first plot. Evidently this land needs phosphoric acid more than any other one element. While phosphoric acid alone may not satisfy the demands of this ground, it suggests the importance of using liberal amounts of this element in preparing fertilizers for this land. Comparing plots 10 and 14, which received the same fertilizers, except that 14 received an application of air-slaked lime, we conclude from this year's work that lime will not prove very beneficial to this soil. It is hoped that a repetition of this experiment may give more beneficial results.

O. C. WHEELER EXPERIMENT—IONIA COUNTY.

	Fertilizers per acre.	Pounds.	Yields per acre.			
			Beans. Lbs.	Beets. Lbs.	Corn. Lbs.	Potatoes. Lbs.
1	No fertilizer		2,320	4,520	5,960	3,240
2	Nitrate of soda	120	1,880	4,540	6,520	1,880
3	Dissolved phosphate rock	240	1,160	2,200	5,480	2,160
4	Muriate of potash	120	1,560	2,560	6,800	2,260
5	No fertilizer		1,600	1,480	5,560	3,200
6	Nitrate of soda Dissolved phosphate rock	120 240	1,840	2,280	6,240	2,700
7	Nitrate of soda Muriate of potash	120 120	2,400	3,440	7,320	3,220
8	Dissolved phosphate rock Muriate of potash	240 120	1,840	2,760	6,560	2,480
9	Nitrate of soda Dissolved phosphate rock Muriate of potash	120 240 120	2,520	3,320	8,440	2,580

Early rain killed many of the beets in this field and as a result they stood very thin on the ground. The relatively high yield on plot 1 indicates the presence of some unnatural condition. A study of the yields of plots 1 to 8 indicate that nitrogen and potash are more needed on this soil than phosphoric acid. This conclusion is further verified by the fact that the addition of phosphoric acid in plot 9 seems to but slightly increase the yield over that of plot 7 without the phosphoric acid. Furthermore, as single elements, nitrogen and potash gave higher yields than phosphoric acid in every case except the potato plots.

L. L. THOMPSON EXPERIMENT—KALAMAZOO COUNTY.

	Fertilizers per acre.	Pounds.	Yields per acre. Beans. Lbs.	Corn. Lbs.	Potatoes. Lbs.
1	No fertilizer	....	220	1,260	1,820
2	Nitrate of soda	120	230	1,410	2,220
3	Dissolved phosphate rock	240	180	1,260	2,500
4	Muriate of potash	120	200	1,280	2,320
5	No fertilizer	....	210	1,420	3,840
6	Nitrate of soda Dissolved phosphate rock	120 240	200	1,130	4,460
7	Nitrate of soda Muriate of potash	120 120	240	1,520	4,100
8	Dissolved phosphate rock Muriate of potash	240 120	290	1,490	4,900
9	No fertilizer	....	400	1,460	....
10	Nitrate of soda Dissolved phosphate rock Muriate of potash	120 240 120	420	1,680	5.220
11	Commercial fertilizer	480	240	1,600	5,180
12	Stable manure (20 loads)	....	400	1,700	6,580
13	No fertilizer	....	220	800	4,020

Beets were sown on this experiment, but the severe rains destroyed them. Plot 5 was in a sag where the wash from other plots materially benefited the crops. Leaving out this plot, there appears a need of complete fertilizers to improve this soil. Further experimenting will be necessary to determine the particular elements most beneficial. Unfortunately, Mr. Thompson will be unable to continue the experiment another year.

BRUCE PHILLIPS EXPERIMENT—MACOMB COUNTY.

	Fertilizers per acre.	Pounds.	Yields per acre. Beans. Lbs.	Beets. Lbs.	Corn. Lbs.	Potatoes. Lbs.
1	No fertilizer	....	520	4,950	1,520	1,360
2	Nitrate of soda	120	480	6,683	1,160	3,200
3	Dissolved phosphate rock	240	420	4,073	1,080	2,080
4	Muriate of potash	120	420	1,588	1,200	2,960
5	No fertilizer	....	360	2,516	460	2,080
6	Nitrate of soda Dissolved phosphate rock	120 240	400	3,031	1,080	1,960
7	Nitrate of soda Muriate of potash	120 120	500	3,608	1,160	2,880
8	Dissolved phosphate rock Muriate of potash	240 120	560	4,857	1,120	3,200
9	No fertilizer	....	360	4,535	640	2,000
10	Nitrate of soda Dissolved phosphate rock Muriate of potash	120 240 120	520	6,125	1,160	2,880
11	Commercial fertilizer	480	440	5,548	960	2,800
12	Air slaked lime	....	320	5,383	560	2,400
13	Hardwood ashes	....	480	7,796	960	3,360
14	No fertilizer	....	400	5,486	560	1,680
15	Stable manure (20 loads)	....	760	11,631	1,840	3,600

Plot 1 of this experiment enjoyed the benefit of head-lands made in plowing and the tramping by the horses in turning at the ends, and the result is in the case of corn and beans a larger yield. Mr. Phillips reports an extremely dry season in this locality, and it is safe to assume that the full benefit of the fertilizers was not enjoyed owing to a lack of water. Plot 4 was in a low place where the beets were planted, and for some unaccountable reason the beets were very small on this particular area. The experiment will be repeated, and it is hoped that more satisfactory results will be obtained.

G. C. LAWRENCE EXPERIMENT—WASHTENAW COUNTY.

	Fertilizers per acre.	Lbs.	Yields per acre. Beans. Lbs.	Beets. Lbs.	Corn. Lbs. Hard.	Soft.	Stover.	Potatoes. Lbs.
1	No fertilizer		440	1,870	2,940	400	2,200	620
2	Nitrate of soda	120	390	2,480	3,400	240	2,440	790
3	Dissolved phosphate rock	240	500	5,190	2,900	320	2,400	760
4	Muriate of potash	120	630	7,500	2,440	280	2,620	900
5	No fertilizer		680	6,630	3,300	290	2,560	760
6	Nitrate of soda Dissolved phosphate rock	120 240	510	7,560	2,970	410	2,560	670
7	Nitrate of soda Muriate of potash	120 120	400	10,730	3,320	240	3,320	900
8	Dissolved phosphate rock Muriate of potash	240 120	600	11,020	2,260	240	2,840	930
9	No fertilizer		460	10,100	2,990	250	2,760	720
10	Nitrate of soda Dissolved phosphate rock Muriate of potash	120 240 120	440	12,000	2,880	210	2,300	720
11	Commercial fertilizer	480	350	6,400	2,850	170	2,100	690
12	Stable manure (20 loads)		690	6,760	2,760	320	3,580	1,340

The extreme uniformity of yields from these plots indicates that the fertilizer was not in any measure assimilated by the plants. Stable manure was applied very late, and was somewhat coarse in character. It is safe to assume that in this light soil the crops suffered on the manured plot because of being cut off from the capillary moisture by the coarse stable manure plowed under just previous to sowing the crop. The experiment will be continued another year.

THE J. Y. CLARK EXPERIMENT—OAKLAND COUNTY.

This experiment was conducted on clay loam soil, sloping slightly to the south, appearing when the experiment was begun to be of a very uniform character. Beans, beets, corn and potatoes were planted. The beet seed, however, absolutely refused to grow. The fertilization and arrangement of the plots was in accordance with a general plan, one plot being added with complete fertilizer and one ton of air slaked lime per acre.

Observations during the growing season revealed many facts in relation to the character and contour of the land, which, together with the extreme dry weather, detracted materially from the value of the results. Mr. Clark's notes state that the chances on plots 7 and 8 are as 3 to 5. In another place there appeared a little sag, giving a slight advantage to that particular area, while a dry, clay knoll, on which the vegetation grew poorly, cropped out on another plot. Stable manure and complete fertilizers generally increased the yield, while an application of one ton of air-slaked lime per acre added thirty per cent to the yield of corn.

C. E. MILLS EXPERIMENT—ANTRIM COUNTY.

	Fertilizers applied per acre.	Pounds.	Yields per acre. Beans. Lbs.	Beets. Lbs.	Corn. Lbs.	Potatoes. Lbs.
2	Nitrate of soda	120	2,920	21,935	3,005	6,405
3	Dissolved phosphate rock	240	2,110	20,305	2,775	5,695
4	Muriate of potash	120	2,180	12,975	3,455	6,865
5	No fertilizer		2,460	20,415	2,585	7,375
6	Nitrate of soda Dissolved phosphate rock	120 240	2,830	22,935	3,745	8,215
7	Nitrate of soda Muriate of potash	120 120	1,600	21,405	3,765	6,635
8	Dissolved phosphate rock Muriate of potash	240 120	2,340	18,605	3,205	10,115
9	No fertilizer		2,680	18,445	3,775	10,835
10	Nitrate of soda Dissolved phosphate rock Muriate of potash	120 240 120	2,330	26,535	3,480	8,545
11	Commercial fertilizer	480	1,980	23,305	3,520	9,405
12	Stable manure (20 loads)		4,840	25,125	4,605	11,445
13	No fertilizer		2,590	14,225	3,275	13,345

We were somewhat unfortunate in the selection of land for this experiment, and were obliged to use a rolling piece of ground which gave some very undesirable inequalities. In this experiment, as in many of the others, it is a noticeable fact that the dry weather prevented our getting the best from the application of fertilizers. Looking at the results of the experiment with beans we observe that the differences in yields are very slight and irregular. The bean crop was harvested before the late rains of the season, and in all probability the differences in yield are due more to the inequalities in the land, the slopes, knolls and sags, than to the application of fertilizers. The yields of corn show a more marked difference in yield as we come to the plots on which complete fertilizers were applied, indicating that the later growth of corn may have enjoyed the effect of fertilizers made soluble by the rainwater. This is also true of the beets and potatoes.

COLLEGE FARM EXPERIMENT.—INGHAM COUNTY.

	Fertilizers per acre.	Lbs.	Yields per acre.									
			Beets. Lbs.	Beans.		Corn.			Potatoes.		
				Grain. Lbs.	Straw. Lbs.	Hard. Lbs.	Soft. Lbs.	Fodder. Lbs.	Large. Lbs.	Small. Lbs.	Total. Lbs.
1	No fertilizer										
2	Nitrate of soda	120	13,160	480	520	1,420	200	1,280	1,910	440	2,350
3	Dissolved phosphate rock	240	11,270	750	450	1,520	200	2,560	2,870	180	3,050
4	Muriate of potash	120	14,300	500	580	1,440	280	1,729	2,300	440	2,740
5	No fertilizer		9,720	640	560	1,520	320	1,840	2,360	290	2,650
6	Nitrate of soda, 120 Dissolved phosphate rock, 240	360	12,140	460	460	1,480	220	2,000	2,580	200	2,780
7	Nitrate of soda, 120 Muriate of potash, 120	240	12,900	550	610	1,620	200	2,120	2,780	230	3,010
8	Dissolved phosphate rock, 240 Muriate of potash, 120	360	13,400	450	430	1,280	200	1,440	2,650	540	3,190
9	No fertilizer		13,030	560	560	1,480	300	2,120	2,450	220	2,670
10	Nitrate of soda, 120 Dissolved phosphate rock, 240 Muriate of potash, 120	480	15,880	620	300	1,460	200	1,640	2,990	360	3,350
11	Commercial fertilizer	480	13,680	480	320	1,320	300	1,280	2,480	160	2,640
12	Stable manure (20 loads)		14,920	680	840	1,360	180	3,200	3,260	240	3,500
13	Average, no fertilizer plots		11,375	600	560	1,500	310	1,980	2,405	255	2,660

The above experiment was conducted on a heavy soil, which in 1895 received applications of fertilizers similar in nature to those used in this experiment. Since 1895 the ground has been uniformly cultivated and cropped.

The crop immediately preceding this experiment was mammoth clover which left the land in excellent condition evidenced by the comparatively high yields of the unfertilized plots.

The indications are that this soil is in need mostly of potash, though a continuation of the experiment will be necessary to prove conclusively this point.

THE H. M. KINGSLEY EXPERIMENT.

This experiment was conducted on land which has for a number of years been used as a general garden, containing at the time the experiment was begun a few rows of raspberry bushes. We attempted to arrange the plots so that each would receive uniform treatment and conditions. The results, while showing a marked increased yield in favor of the fertilizers applied, was, owing to inequalities, drainage, and the shade of one or two trees near by, very unsatisfactory. Mr. Kingsley will conduct the experiment another year on a very desirable piece of ground on another portion of his farm, from which we hope for more satisfactory results.

A. E. GREGORY EXPERIMENT.

Mr. Gregory's experiment was on a very uniform, level and apparently ideal piece of ground. A severe rainstorm, however, following immediately after the planting of the seed, washed many of them out and ruined the results of a part of the experiment. The work will be continued another year on the same soil, paying particular attention to the effect of fertilizers on the growth of the clover crop. Clover was sown on a portion of Mr. Gregory's experiment, resulting in a very satisfactory catch, which promises a mammoth yield.

Average results from soil test experiments.	Corn, 11 plots. Lbs.	Beans, 10 plots. Lbs.	Potatoes, 9 plots. Lbs.	Sugar beets, 8 plots. Lbs.
Nothing plots	2,242	913	3,652	8,035
Nitrate of soda	2,389	1,091	3,323	8,988
Dissolved phosphate rock	2,439	822	3,272	8,714
Muriate of potash	2,760	836	3,251	8,169
Nitrate of soda and dissolved phosphate rock	2,434	908	3,743	9,766
Nitrate of soda and muriate of potash	2,423	908	4,005	10,199
Dissolved phosphate rock and muriate of potash	2,307	921	4,553	9,764
Complete fertilizer—nitrate of soda, dissolved phosphate rock and muriate of potash	2,750	1,000	3,806	10,779
Commercial fertilizer	2,125	669	4,262	10,487
Stable manure	2,421	1,283	4,992	12,386

The above table is made by averaging the yields from all those experiments which gave complete results. It will be noticed that the fertilized plots of corn and beans show but slight increased yields over the nothing plots. These crops matured during the dry weather, and probably did not enjoy the full benefit of the fertilizers applied, while the beets and late potatoes made considerable growth after the fall rains and no doubt were more largely benefited by the plant food applied in the fertilizers.

The extreme dry weather of the summer of 1899, together with the fact that this soil was selected without careful notes nor knowledge of its natural condition, and this being the first year of the trial, excuse the irregularities and indifferent character of these results. We trust that the first year's experience may prove a valuable preliminary to the experiments which are to follow on some of these fields, seven of which are being continued. The nothing plot average is made from the entire 43 plots of all the experiments, on which no fertilizer was applied.

MUCK EXPERIMENTS.

It is estimated in the State of Michigan that about one-seventh of its area is swamp or muck land. These muck deposits are distributed quite generally throughout the State, so much so that it is seldom that we find a farm of one hundred acres on which there is not a few acres of this kind of soil. The College farm has several such areas. These muck fields are usually so surrounded by higher land that the approach of cold weather in the fall attacks these areas first. The cold atmosphere flows down the hills and unless the air drainage leads towards a river or lake the swamp lands will be the first in the locality to be attacked by frosts. Our experiments in connection with muck soils were begun on a portion of field No. 13 of the College farm, which was in corn during the summer of 1898. A killing frost on July 10th ot that year settled on this muck area, and completely destroyed about two acres of the corn. Immediately following the visit of this remarkable frost the ground was plowed, and laid off into plots of one-tenth acre each, the dimensions being 22 feet by 198 feet, with three-foot paths between. Eight plots were this year devoted to the experiment. Plot 1 received leached ashes from an ashery near Lansing, where the ashes are allowed to accumulate in large quantity. The owner charges the nominal sum of ten cents a wagon load for them, and yet hundreds of loads are left there without a purchaser. Analysis of these ashes showed .36 per cent potassium oxide, 1.43 per cent phosphoric acid and 26.92 per cent calcium oxide. According to commercial valuation the phosphoric acid and the potash in these ashes are alone worth $1.65 per ton.

Plot 2 received a coating of sand from the College gravel pit equal to one inch in depth; this required fourteen wagon loads on the tenth acre.

Plot 3 was left untreated.

Plot 4 received air-slaked lime (60.70 per cent CaO) at the rate of two tons per acre, applied on the plowed surface and thoroughly harrowed in.

Plot 5 received Homestead Bone Black Fertilizer, at the rate of 400 pounds per acre (2.53 per cent ammonia, 11.24 per cent available and .26 per cent insoluble phosphoric acid and 1.61 per cent potash).

Plot 6 received a mixture per acre as follows: 290 pounds dissolved Bone Black, 53 pounds nitrate of soda, and 12.2 pounds sulphate of potash. This mixture was prepared to furnish fertilizing elements equal to that which was applied in the Homestead Bone Black Fertilizer.

Plot 7 received two good loads of well rotted barn yard manure, which had lain three or four months in the compost heap.

Plot 8 received no fertilizer, but was thoroughly rolled. A heavy iron roller was well loaded and drawn over the plot six times.

The first year's crops, which were sown about July 23, were duplicated on each half of the ground, and were as follows:

Crimson clover, turnips, corn, peas, buckwheat, rape, barley, oats, Hungarian grass, millet, radishes and cabbage. As the planting was very late and the season somewhat dry, no definite results were obtained the first year. In every case the fertilizers increased the yield, and the barnyard manure gave the best results. Radishes made a good growth on all plots, but were very strong in flavor. Another killing frost on September 13 practically terminated the experiments for the year. We were surprised to note, however, the very slight effect of the application of air-slaked lime on this soil. However, the drought that occurred during that period may account for the slight effects of this and all the other fertilizers.

In 1899 the work was resumed, adding nine new plots, and giving air-slaked lime a more thorough trial by applying it at the rate of one ton per acre on one-half of all the new plots except the unleached wood ashes. We were limited in area, and were obliged to use but one-twentieth of an acre for each of the plots added to the experiment this year. The following plan gives the arrangement of the plots, their dimensions and the kind and amount of fertilizers applied:

Plan of Soil Test Experiment on Muck Land—College farm.

NORTH.

198 ft.

1 Leached ashes. 34 ft.
5 tons per acre—applied in 1898.

2 Sand.
Applied 1 inch thick in 1898.

3 Nothing.

4 Air slaked lime.
2 tons per acre—applied in 1898.

5 Commercial fertilizer.
400 lbs. per acre—applied in 1898.
200 lbs. per acre—applied in 1899.

6 Home mixed fertilizer.
355.2 lbs. per acre—applied in 1898.
177.6 lbs. per acre—applied in 1899.

7 Stable manure.
20 loads per acre—applied in 1898.

8 Nothing. EAST.
Ground thoroughly rolled.

9 Nitrate of soda. 11 ft.
400 lbs. per acre in 1899.

10 Dissolved phosphate rock.
800 lbs. per acre in 1899.

11 Muriate of potash.
400 lbs. per acre in 1899.

12 Nitrate of soda, 400 lbs. per acre.................... } in 1899.
Dissolved phosphate rock, 800 lbs. per acre }

13 Nitrate of soda, 400 lbs. per acre........ } in 1899.
Muriate of potash, 400 lbs. per acre }

14 Dissolved phosphate rock, 800 lbs. per acre } in 1899.
Muriate of potash, 400 lbs. per acre.... }

This half of these plats received air slaked lime at the rate of one ton per acre.

15 Nothing.

16 Air slaked lime.
2 tons per acre.

17 Wood ashes—unleached.
1 ton per acre.

SOUTH.

The crops this year were as follows, and were sown in duplicate across all the plots: Garden peas, golden wax beans, soja beans, radishes, spinach, lettuce, onions, sorrel, sugar beets, ruta bagas, garden beets, watermelons, squashes, cucumbers, buckwheat, millet, corn, sunflower, celery, tomatoes and potatoes.

The following notes and results were obtained from the original eight plots of the experiment:

Plot No.	Fertilizers applied.	Peas, 2 rows. Lbs.	Radishes, 2 rows. Lbs.	Sugar beets, 6 rows. Lbs.	Table beets, 1 row. Lbs.	Onions, 2 rows.	
						Lbs.	Ozs.
1	Leached ashes	5	29	93	10½	......	3
2	Sand	4¼	32½	73½	14	1	11½
3	Nothing	5½	48¼	26	5	3	7
4	Air slaked lime	5¼	28¾	20	5	......	14
5	Homestead fertilizer	6¼	36¼	17½	4¾	8	½
6	Home mixed fertilizer	5¼	48¼	53	6¼	9	½
7	Stable manure	4¼	87¼	124½	35½	19	11½
8	Nothing (thoroughly rolled)	6	52¼	56½	4¼	17	8½

Plot No.	Fertilizers applied.	Potatoes, 2 rows.		Sunflowers, 2 rows. Stalks and heads. Lbs.	Corn, 2 rows. Entire plant. Lbs.	Millet, 1 row. Lbs.
		Lbs.	Ozs.			
1	Leached ashes	2	3½	28¾	5½	¾
2	Sand	2	11½	33¼	21½	1½
3	Nothing	2	7½	18½	7¾	1¼
4	Air slaked lime	2	½	8½	7¾	2
5	Homestead fertilizer	5	9½	16¾	10¾	8¾
6	Home mixed fertilizer	3	13½	15¾	16¼	6¾
7	Stable manure	7	1	45¼	56½	22½
8	Nothing (thoroughly rolled)	6	11½	23½	11	5

Plot No.	Fertilizers applied.	Tomatoes, 1 row. Lbs.	Squashes, 4 hills. Lbs.	Soy beans, 1 row.		Flat turnips, 4 rows. Lbs.
				Lbs.	Ozs.	
1	Leached ashes	26	5	2	......	47¼
2	Sand	21½	11¼	4	8	37
3	Nothing	26½	26	6	7	17¾
4	Air slaked lime	11½	1¼	4	14	14¼
5	Homestead fertilizer	46½	32	6	3	8
6	Home mixed fertilizer	40½	48½	8	1	24
7	Stable manure	144½	195½	4	0	92½
8	Nothing (thoroughly rolled)	45½	32	8	5	13

Plate I. Table Beets.

Plate II. Flat Turnips.

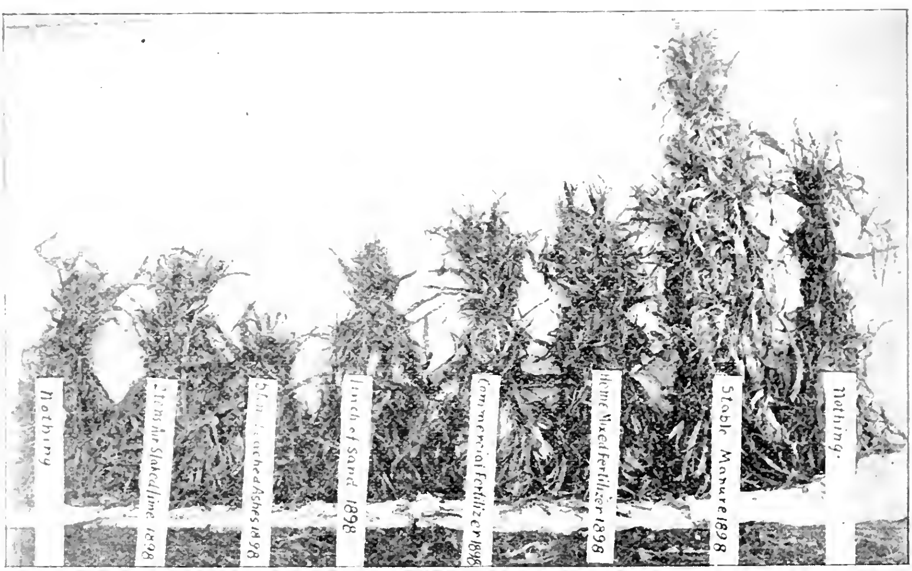


Plate III. Corn.

The series of plots added to the experiment, as stated before, were of necessity but half as large as the former series, being eleven feet wide and 198 feet long. The fertilizers applied were in accordance with the regular soil test experiment, with the addition of lime and hardwood ashes. The tables given below indicate the arrangement of the plots, and the kind and amount of fertilizers applied. The row of peas, beans, radishes, sugar beets, ruta bagas, spinach, lettuce, corn, sorrel and onions sown on the series mentioned before were continued across these plots. The yields of those producing in a sufficient degree of uniformity and without accident are given in the tables below. Those not mentioned are left out because of serious inequalities in the resulting crop, due to accidental or otherwise unavoidable circumstances.

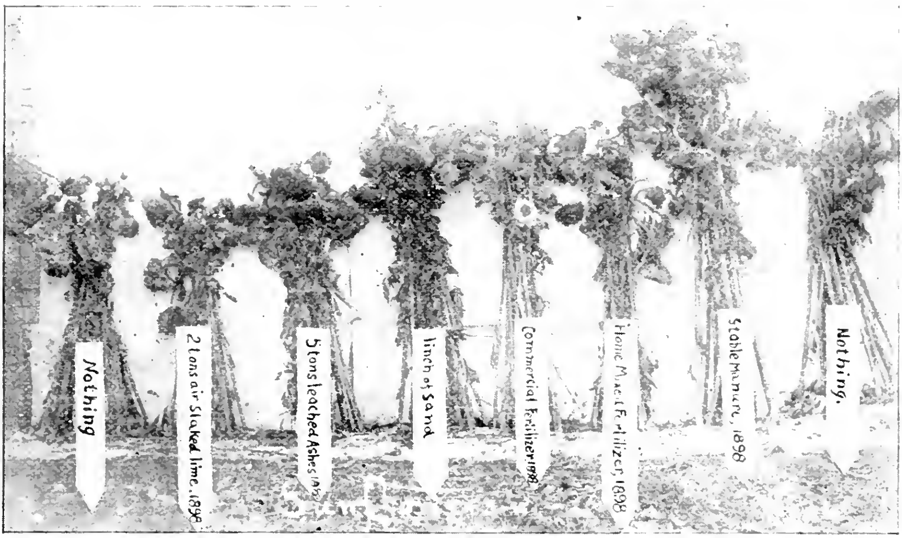


Plate IV. Sunflowers.

Plot No.	Fertilizers applied.	Pounds per acre.	Sugar beets. 6 rows, 11 ft. long. Unlimed. Lbs.	Sugar beets. Limed. (1 ton.) Lbs.	Radishes. 1 row 11 ft. long. Unlimed. Lbs.	Radishes. Limed. (1 ton.) Lbs.
9	Nitrate of soda	200	14	10	5	13½
10	Dissolved phosphate rock	400	10¾	11	8½	15
11	Muriate of potash	200	27½	12½	9¾	10¼
12	Nitrate of soda Dissolved phosphate rock	200 400	14½	9	8¼	9¼
13	Nitrate of soda Muriate of potash	200 200	29½	27	7	8¾
14	Dissolved phosphate rock Muriate of potash	400 200	18½	31½	10¼	13
15	Nothing		11½	....	8¾	....
16	Lime	2,000	16½	....	8¼	....
17	Lime	4,000	21½	....	6¾	....
16	Lime	6,000	26½	....	8	....
19	Hardwood ashes	2,000	33	....	31	....

Plot No.	Fertilizers applied.	Pounds per acre.	Onions—one row. Unlimed. Lbs.	Ozs.	Limed, 1 ton per acre. Lbs.	Ozs.	Peas—one row. Unlimed. Lbs.	Limed, 1 ton per acre. Lbs.
9	Nitrate of soda	200	2	4.	1	11.	.75	.25
10	Dissolved phosphate rock	400	2	10	1	1.	.5	1.
11	Muriate of potash	200	1	14.	1	9.5	.5	1.25
12	Nitrate of soda Dissolved phosphate rock	200 400	2	1.	..	6.5	2.	2.5
13	Nitrate of soda Muriate of potash	200 200	3	10.	1	7.	1.5	1.5
14	Dissolved phosphate rock Muriate of potash	400 200	1	15.	1	6.5	1.	1.
15	Nothing	......	......	9.5	......	......	.75	....
16	Lime	2,000	......	3.	......	......	.75	....
17	Lime	4,000	......	13.	......	......	1.	....
18	Lime	6,000	1	7.5	......	......	1.5	....
19	Hardwood ashes	2,000	2	13.	......	......	3.	....

SUGAR BEETS HARVESTED OCTOBER 20.

Plot No.	Fertilizers applied.	Pounds per acre.	Unlimed. Yield. per plot 11 ft.x54 ft. Lbs.	Yield per acre. Lbs.	Limed. 1 ton per acre. Yield per plot 11 ft.x54 ft. Lbs.	Yield per acre. Lbs.
9	Nitrate of soda	200	198	14,520	120	8,800
10	Dissolved phosphate rock	400	95	6,966	68	4,986
11	Muriate of potash	200	227	16,646	157	11,513
12	Nitrate of soda Dissolved phosphate rock	200 400	132	9,680	135	9,900
13	Nitrate of soda Muriate of potash	200 200	235	17,233	218	15,986
14	Dissolved phosphate rock Muriate of potash	400 200	211	15,473	220	16,133
15	Nothing	....	154	11,293	....	....
16	Lime	2,000	145	10,633	....	....
17	Lime	4,000	217	15,913	....	....
18	Lime	6,000	215	15,766	....	....
19	Hardwood ashes	2,000	340	24,933	....	....

SUMMARY OF MUCK EXPERIMENTS.

1. In general, the result of the muck experiments indicate a uniformity in the requirements of the various crops and that stable manure meets those requirements in fuller measure than anything else. It appears that the legumes tried, garden peas and soja beans, are the only exceptions to this rule.

2. For the effect of these manures on yield and quality of sugar beets the reader is referred to pages 103-106 of bulletin 179.

3. Air-slaked lime, which in the past has been highly recommended as a treatment for muck land, acted on this even slightly acid muck, in opposition to our expectations, for on plot 4, where it was applied at the rate of two tons per acre, the yield is generally less than on 3, where nothing was applied. Plots 15 to 18 indicate an increased yield, as the quantity applied is enlarged.

4. Sand has given contradictory results, though frequently its yield is higher than the adjacent "nothing" plot. These results are in no measure the entire benefit to be

derived from this one application, but it is still a problem whether it will pay to apply sand to a muck field at the rate of 140 loads per acre.

5. Leached ashes gave results similar to those from sand, and though yet inconclusive, we believe that, where this material may be had for a few cents per wagon load and is within four or five miles, it may be applied with profit.

6. So far, the complete fertilizers do not give results that will warrant their purchase in considerable quantities for muck land.

7. Unleached wood ashes gave very satisfactory results, as did also the mixture of phosphate rock and potash salts, indicating the lack of mineral manures and an abundance of nitrogenous manures in this soil.

NOTES ON CLOVER.

Throughout the State there exists a manifest desire for methods by which the growth of clover may be made a more certain factor in the crop rotation.

Until about ten years ago but little difficulty was experienced in securing a good catch and successful crops were a general result. With the visitation of the clover root borer and the clover leaf weevil, the clover crop of the entire State was practically wiped out. The weevil was finally followed by a parasite, which preyed upon the weevil, practically destroying it.

The entire loss of the clover crop for a period of six or eight years naturally reduced the organic content of the older Michigan soils to such an extent that good seedings with the wheat crop of clover are secured only by sowing on the richest and most highly manured soils and under the most favorable circumstances.

On the newer lands, where the virgin humus has not yet been severely reduced, there seems to be little difficulty in securing satisfactory seedings by sowing the clover seed in the spring on wheat or some other cereal. Where the fields are prepared for wheat by summer fallowing, or where the ground is very rich and receives the best possible preparation, or where large quantities of stable manure or other fertilizers are applied, the clover catch is generally insured.

The above observations led us to conclude that where the insect is not doing its destructive work, the main causes for the failure of the clover crop are, exhaustion of the elements of plant food and organic matter or humus in the soil, while the remedies lie in restoring and supplying these materials and providing better cultivation. The problem is first to supply the organic matter, the same being provided most acceptably from the roots and stubbles of the clover crop itself. But the beginnings must be secured in some other way.

In those sections where clover has refused to grow when sown with a nurse crop, there seems to be no other way than to prepare the ground in the early spring and sow the seed alone, giving it complete possession of the ground.

In the spring of 1898 clover seed was sown on the College farm as follows:

Field No. 16, which was then in wheat, the third farm crop the field had ever produced. Seed was sown broadcast, and except on the most exposed knolls, a very satisfactory seeding and subsequent crop of clover hay was realized.

Field No. 3, experimental plots, which has been under cultivation and continuously cropped for forty years. Two one-eighth acre plots only four rods apart were sown at the same time. One on wheat which yielded 42 bushels per acre, and the other on ground especially prepared for the clover crop, and the clover given entire possession of the ground. The result was an entire failure of the seeding on the wheat and a very successful catch on the specially prepared ground, and a yield of 4,067 pounds of hay as a first crop. While the above experience may not be repeated in every similar case, the conditions are such that a natural conclusion may be safely drawn.

The most desirable time to sow clover seed is an experiment now in progress. The plan is to sow a plot each month with conditions as near uniform as possible to provide. This experiment was begun in April, 1899, sowing the seed about the 25th of the month. At the present writing, May 1, 1900, the conditions of the seedings the past year are as follows:

April seeding, perfect catch, excellent growth, promise of a good crop.

May seeding, stand as good as April, though not quite so forward.

June seeding, a perfect stand, a little smaller than the May seeding.

July seeding, complete failure.

August seeding, medium stand, short and unpromising. It may possibly produce half a crop this year.

September, October and November seedings, clover complete failure, some timothy and many weeds.

December, January, February and March seedings about equal in number of plants, all small, though promise a fair catch.

April seeding (1900), seeds just beginning to sprout.

NOTES ON SAND LUCERNE.

On April 26, 1897, two small plots of one-tenth acre each were sown to sand lucerne, using fifteen pounds of seed per acre. The soil was of a very light, sandy nature, much of the surface having been hauled away to fill in around the College barns. The sand was so light that when not held down by a growing crop, it drifted badly in a strong wind.

The sand lucerne was given entire possession of the ground, though it did not produce a crop until the second year, when it was mowed three times, producing a total on one plot of 6,800 pounds per acre, and 5,917 from the other. By cutting it as soon as it came to full bloom most excellent hay was made.

The winter of 1898 and 1899 was a most severe one and killed fruit trees, clover, wheat, and other hardy plants. The sand lucerne, however, withstood the winter remarkably well and gave an excellent yield in four crops amounting to 10,580 pounds per acre on the better plot. The first cutting was made May 31.

The sand lucerne is a legume so nearly resembling alfalfa that only a careful study of the two reveals a slight difference. Its remarkable behavior on the College grounds recommends it for light sandy soils where the moisture is a considerable distance below the surface.

So far as we know, the seed has never been produced in this country. The station obtained a quantity this year and has distributed about one hundred and fifty samples to farmers of the State, with instructions for giving it a trial.

WHEAT EXPERIMENTS—TEST OF VARIETIES.

On the College wheatfields, varieties of wheat were sown in the fall of 1898. Each variety was given a strip of ground 94 rods long and wide enough to make an acre or more. These strips were of as nearly uniform character as could be selected for such large areas, and comprised portions of low ground, together with an exposed knoll and a considerable area of level ground. The test was made in two different fields. The Dawson Golden Chaff was sown in both, and in making the calculation of the yield in field 14, where the soil was lighter and the yield much smaller, a computation bringing the yield to the basis of Dawson Golden Chaff was made as follows: In field 8 the Dawson variety yielded 30.12 bushels per acre, and in 14 the yield was 23.9, a ratio of 1.26 to 1. In fixing the yields of the varieties grown in field 14 the actual yield was multiplied by 1.26. Below is a table giving the varieties, in their order, the field number, the computed yield per plot, and the yield per acre:

Name of variety.	Field.	Area of plot. Acres.	Yield per plot. Lbs.	Yield per acre Bu.
Gold Coin	8	.913	1,758	32.08
Dawson Golden Chaff (seed treated)	8	.913	1,750	31.95
International No. 6	8	.913	1,748	31.9
Dawson Golden Chaff (seed untreated)	8	.913	1,650	31.12
Russian	8	.913	1,638	29.9
Fulcaster	14	1.166	1,959	28.01
Jones' Square Head	8	.913	1,474	26.9
White Clawson	14	3.018	4,486	24.07
Rudy	8	.913	1,206	21.83
Buda Pesth	14	4.072	5,258	21.52
Red Clawson	8	.913	1,117	20.38
Long Amber	14	1.338	1,608	20.03
Fultze	8	.913	865	15.78

The Red Cross and Currell were sown in field 14. The Red Cross was entirely on the dry, exposed knoll, and resulted in almost complete failure, while the Currell grew so poorly and was so full of weeds that its yield was not computed. In justice to the Buda Pesth variety, it should be stated that the soil on which it grew was not nearly so good as the average of the soil for the other varieties. Had it grown along with the Russian, Dawson, and Gold Coin, in No. 8, its yield would probably have been nearly up to these varieties. In harvesting special care was taken to cut first, and remove from the plot on which the yield was computed, all of the wheat grown on the head lands or near the fence, and to avoid dead furrows and back furrows occurring on the plots. They were generally at the dividing line between the varieties. In general, the varieties stood up well, even through a low piece of ground where the wheat usually lodges badly. The International No. 6, Dawson, Gold Coin, and the White Clawson, resemble each other quite closely, as they appear in the field. The Russian and Buda Pesth are bearded varieties with fine straw and lodge readily. Indeed, these varieties in the past two seasons have both leaned so badly to the east at the time of harvesting that it has been necessary to carry the swath in reaping them. They are, however, both good milling varieties, and we hope to secure for them such yields as will warrant their more thorough introduction. The Currell and Red Cross are beardless, red varieties, but so far their behavior does not warrant their adoption in this locality.

As to white varieties, we feel perfectly safe in recommending the first three named on the list, as they give excellent yields, stand up well, and are accepted as good varieties by the millers.

CULTIVATION EXPERIMENT WITH WHEAT.

On a level and uniformly fertile portion of field No. 8, the following experiment in cultivation was completed in 1899, and is being repeated in duplicate this year in field No. 6. Long narrow strips were selected. The field was oat stubble, the previous treatment of which was in line with the rotation practiced on the College farm, although a portion of the field had been plowed for oats in the fall and another part in the spring. In the table below fall plowing was done on the gang plowed plot 1, the first late plowed strip, plot 3, and the early plowed portion, plot 2, while the plots harrowed before plowing and the late plowing not harrowed were plowed for oats in the spring. In the following table is the description of the preparation of the ground and the yield per acre of the wheat crop:

	Yield per acre, bu.
1—Gang plowed, 4 inches deep, with a vineyard gang plow, a tool with which two horses can plow four acres per day. This preparation is followed by two harrowings and the grain drill..............................	23.74
2—Early plowing. The ground was plowed with the ordinary walking plow to the depth of 8 inches, immediately after removing the oat crop. The plow was followed promptly by the roller and the harrow, harrowing done at intervals of seven to ten days until the wheat was sown..............	23.65
3—Late plowing. This soil was plowed for oats in the fall, but after the oat crop was removed the ground was allowed to lie undisturbed until the day before the wheat was sown, when it was plowed, rolled and given two harrowings with the spring tooth harrow and one with the Acme......	19.00
4—This ground was plowed for oats in the spring. Immediately upon removing the oat crop, on the day that the early plowing was done on plot 2, this ground was harrowed twice, with an ordinary spring tooth harrow. The operation being repeated again two weeks later. On the day plot 3 was plowed this plot was also plowed and prepared the same as plot 3, except that only one harrowing was necessary............................	22.93
5—Plowed for oats in the spring and otherwise treated the same as plot 3....	16.3

While as a result of this experiment, the yield from the shallow plowing is the highest, we are not prepared to say that we advocate plowing oat ground but four inches deep in preparation for the wheat crop. However, if such an experiment as this repeated several times would give similar results, the great saving in time in preparing the wheat ground by this method would recommend it for general practice. The gang plowing did not prepare to a depth of four inches what the ordinary farmer would call an ideal seed bed for wheat. The oat stubble was not completely covered, and the ground had the appearance of being very dry and dusty and very poorly prepared.

However, the results warrant the repetition of the experiment, at least. The early plowing process on plot 2, followed by the roller and repeated harrowing, approaches nearly as one can, the conditions of a summer fallow with an oat stubble. Although the yield is a few pounds less per acre than on the gang plowed strip this method is the one upon which we can depend with a great degree of certainty. Late plowing on plot 3 was done on September 16, the ground having dried and baked and become lumpy, almost refusing to admit the plow. It was impossible to prepare this ground and that of plot 5 to a condition anywhere near as fine and satisfactory as upon the other three plots. However, the condition was not unlike that observed on many farms where the rush of other work delays the plowing until the last minute before time to seed to wheat. It is true that a little less work was expended on this plot than on plots 1, 2 and 4, but the loss of over four bushels to the acre does not warrant this economy of labor. The method of preparing plot 4, though not an entirely new one, is seldom practiced in ordinary farming. The idea of harrowing the ground as soon as the oat crop was removed was to prepare at the surface of the ground the dust mulch to prevent the further escape of moisture until the time of plowing. Plots 4 and 5 were comprised in a "land," and received exactly the same treatment with the exception of the harrowing, the dead furrow of the land being the dividing line between the two plots. The man who did the plowing remarked at the time, that the ground on the harrowed half of the land was more moist, plowed easier, and was much less lumpy. In the preparation which followed the plowing it could be plainly seen that the harrowed half of this land was much more mellow and presented a more desirable appearance as a seed bed. It was further observed that on plots 1, 2 and 4, where the ground had been either plowed or harrowed early, there were no oats growing after the wheat was sown. The early cultivation of the ground having covered the oats, they grew, and later cultivation destroyed them, while on plots 3 and 5 the oats appeared in great quantities, seeming to crowd the wheat and check its growth. The only difference between plots 3 and 5 is the fact that 3 was plowed in the fall for oats, and 5 was plowed in the spring.

As a result of this experiment we may conclude that whatever operation may be performed to conserve the moisture immediately after removing an oat crop will result in an increased yield of the succeeding wheat crop. While allowing the ground to dry and bake, and become hard and difficult to prepare, is not only a waste of time and labor, but injurious to the wheat crop. If the results obtained in plots 1 and 4 can be taken as conclusive, the treatment of these plots suggests a more rapid and cheaper method of preparing the oat stubble for wheat, at the same time conserving the moisture which is too liable to waste at this dry period of the year.

TOP DRESSING VS. PLOWING UNDER MANURE.

Two areas of ground, which previously had received similar care and treatment, were selected for this trial. A land four rods wide and 94 rods long was divided in the middle. On the one-half was spread a liberal dressing of well rotted barnyard manure, which had lain in the compost heap during the summer. The ground was then plowed and on the other half a similar application of manure from the same heap was made as a top dressing. From the plot on which the manure was plowed under we harvested 30.32 bushels of wheat per acre, while from the top dressed plot the yield was 29.62 bushels, being but 42 pounds less per acre, an amount within the probable limits of error. The difference in the yield from these two practices is not enough to warrant the drawing of any definite conclusions.

A POPULAR DISCUSSION OF PURE MILK SUPPLY.

BY C. E. MARSHALL.

Bulletin 182.—Bacteriological Department.

The writer has been urged by many practical dairymen, butter-makers and cheese-makers, to prepare a short treatise on the above subject, that the milk producer shall be able to understand the importance of securing pure milk, not only for city consumers, but for the purpose of making butter and cheese. No class of dairy operators so fully appreciate the value of pure milk as the butter-makers and cheese-makers who are engaged in factories where the patrons control affairs and the men whom they perhaps employ are obliged to take what they furnish them. The city consumers find much fault concerning their milk, but unfortunately they are largely to blame for the defects of their own milk supply. They expect that a pure milk is obtained with as little expense as the diluted solutions of filth which they now use. By their own penuriousness they ask the milkman to bring them this grade of milk. Why then should they find so much fault?

My words are for those who supply milk to cities, to creameries, to cheese factories, and if those who are supplying milk to their own families are ready for a word of warning, I will include them within this list.

Fortunately there are a few milk producers in the State who are making serious efforts to secure a pure milk and they are included among the most successful in Michigan. Success in the making of butter and cheese, as well as in the furnishing of milk to cities, will as inevitably follow as day the dark and dingy night, and whether one makes a financial success of it will be dependent upon himself as it is at present, but carrying into effect the more advanced ideas will require greater skill and knowledge than are needed in simply milking in dirt and filth.

Most of our ideas in regard to the handling of milk have come to us via tradition. Our fathers used milk as we have it, milked it in the same way, and, so far as we know, did not die from its use. We trust that they did not. Our fathers lived in a one-roomed log house, but we are scarcely willing to follow their examples. Yet when we consider what some of our ancestors did, we are put to shame that we have not moved faster or learned more. A short time since, it was my fortune to listen to a lady much interested in dairy problems, who stated that her great grandfather had sold milk in bottles to people in the city of Edinburgh, Scotland, nearly two hundred years ago. His neighbors laughed at him, as they do in these modern times, but he deserves a monument for his wonderful insight. With the abundance of facts at our disposal, it seems strange that we should continue to do what we recognize to be wrong.

The conditions of life as it existed then were somewhat different from those found now. Milk was not shipped from great distances to supply large centers of population. Usually the milk was consumed within a reasonable number of hours after drawing. Butter and cheese were not made for the purpose of sending thousands of miles. The exchange of dairy products was very limited compared with present commerce. In the early days of this country, farmers sent their surplus butter to the nearest store, where it was mixed with the products of a hundred other farms, barreled and shipped to the nearest city of any size. The storekeepers, in preparing this butter, would work over the entire amount at their disposal, salt it to suit their taste and pack it. Now such methods are employed by a few firms which buy only the poorest grades of butter found upon the market, at a few cents per pound, work it over with fresh milk, salt it and color it and put it again upon the market as a high grade butter. Several modified methods are used in renovating butter to render it fit for consumption. If all made good butter, what would become of these firms? Now, no

matter what the milk product is, if it is good it goes upon the market with its individual characteristics. It is judged as an individual lot and is sold as such. A man without any individuality is always the same as other men—so with milk products.

Another encouraging feature may be added to the departure of haphazard and empirical methods of older days—it is the increase in number of pioneers who are now making efforts to overcome the faulty habits under which we have developed. These pioneers are making a success of their ventures, and as time goes on this success will come more cheaply. They have demonstrated in a practical way the uselessness of quibbling over what is known to be erroneous. The cry which usually springs forth with the mention of these successful dairymen precludes any rational basis upon which to found judgment. The fact that some capitalists have built up some of the model dairies as a diversion, places a brand upon the entire scheme for certain unprogressive types, but fortunately many model dairies furnish the only source of revenue to their owners. The first model dairy may have been an innovation, but the increasing numbers must of necessity soon lead to a practical adjustment. One of the most serious drawbacks to progressive dairying is the too common notion that the old ways are good enough, that the new are impossible and impracticable. A "golden fleece" on the back of the sheep will be necessary to sustain the running operations of the dairy, is a pitiful belief, for it signifies that such an individual's ideals are what he is and not what he should be.

There is much importance to be given to the present management or sales in first grade dairies. Thus far private customers have been found in sufficient numbers to consume all the best dairy products at very remunerative prices. The number has not yet been exhausted: moreover it is fair to suppose that the demand for higher grade dairy goods will increase instead of diminish. Consumers are gradually learning the value of purity in food, and no one can better teach them the difference between what is pure and what is polluted than the producers themselves by a systematic education. Of course there will be those people who will pay one cent per quart less to obtain diluted filth rather than secure pure milk, and this in spite of any educational advantages offered them. There are all stages of development in the world and we must not become discouraged because the ape does not speak.

The preceding remarks may not partake of the teachings which ought to emanate from a bacteriologist or hygienist, yet they are the questions which must first be answered before the dairyman is willing to consider bacteriological or hygienic problems. Although these problems of purity should be first in the mind of every milk producer, unfortunately, however, they have always been considered last, to the great detriment of mankind.

It is not the wish of the writer to draw lurid pictures of the hygienic and bacteriological environments of some dairies which have come under his observation, or to depict existing conditions on a large per cent of farms, devoted to some extent to dairying, for the purpose of sensationalism; it is rather his intention to state in plain language what is known to almost every farmer, that the lessons to be gained therefrom may be immediately applicable. What follows is the result of the author's personal observation in the bacteriological and hygienic investigations of dairies and stables.

1. A visit to A's stable, which represents our first type of dairy operations, was made with the intention of studying the condition of the stable, the cows and the manner of miking. A kept two cows, but these two cows stand for many in larger dairies, in a stable constructed in a very loose manner and just large enough to accommodate the cows and a single horse. A part of the milk obtained from the cows was sold for household purposes, making the investigation of especial interest. The floor of the barn was covered with at least six inches of manure, which had evidently been accumulating for some time. The bedding consisted of coarse corn stalks. The cows' hind quarters were plastered over with a cake of manure at least three-quarters of an inch thick. This condition extended along the bellies of the cows nearly as far as the shoulders. The hair was long on the udder and at the ends of many of the hairs were attached various sized lumps of manure. The teats contained scales of dry manure. The cows were poor and received only corn stalks. There was sufficient light and air in the stable. No exercise was allowed the cows, which remained in the stable a good share of the year.

In milking the man gave no attention to his person or hands. He simply brushed off the udder in a sweeping motion, placed the pail underneath the cow, milked with one hand into the other held over the pail, the surplus milk running through his fingers into the pail, then reversed hands and did the same. His hands were thoroughly

wet when he began milking and as he milked the dirt on the teats began to loosen, making a semi-fluid mass with the milk and dripping from the lower part of his hands into the milk pail. This puddling process continued through the milking, occupying nearly ten minutes. What was done with the milk after leaving the stable I was unable to ascertain. It was not cooled or aerated, however. The house was clean and tidy and doubtless the milk was handled with the greatest care lest it might receive a speck of dust.

It may not seem possible to many that in our present state of civilization such barbarious methods are still in vogue; yet there is no small per cent of similar or even worse dairies. Added to the above acts of barbarism may be cited another even more filthy and pernicious habit,—it is the act of expectorating into the hands before beginning to milk, for every man that milks knows that much of it will find its way into the milk pail before completing the milking process.

So much filth is not tolerated in other foods, in fact, foods of other kinds are discarded if a little mineral dirt gets into them, but in the case of milk, no amount of organic filth renders it unfit for use and it is not an uncommon sight to find in the bottom of a glass of milk a semi-fluid layer, black and suggestive. If this layer of dirt be associated with the condition of the cows above and the method of milking, it does not require an imaginative mind to depict to ourselves the nature of the solution of filth. In regard to the bacteriological and hygienic significance of such milk, more will be said later.

2. The second type of dairies visited shows marked improvement over the first type, but in making my estimation, more dairies approach nearer the first type than this second type. As I stated in the first case, in what is outlined in these representative types, for it would be unnecessary for me to discuss the many places visited in detail, inasmuch as they may all be assigned to three distinct types with all grades between, is delineated the entire field of dairying and especially that part which must answer for polluted milk.

An effort is made in the second type to secure comparatively clean milk. The barn is not especially designed for dairying and is difficult to clean or disinfect; however, the floor is kept free from actual filth by the use of the shovel, and sufficient clean straw is employed for bedding. The cows are fairly clean. The cracks and holes in the sides of the stable permit plenty of fresh air to enter, but there is little sunlight. The milking is done in the stable usually while the cows are eating and the straw is nearly knee deep about the animal. The milker's person is comparatively neat and his hands are quite clean—as clean as could be expected after handling the various implements in the stable. He sits down to the cow, brushes off the udder in a more or less indifferent manner after crowding into a dirty and filthy stall or working his way down between two cows. He milks with dry hands into a comparatively clean pail, and when he finishes, on the foam formed by milking there will be seen only a sprinkling of dirt, which is easily distinguishable to the naked eye. The milk is carried some distance, after a ten gallon can or several pails have been filled in the stable, to the milk house, where it is commonly cooled by stirring while the can rests in running cold water.

There is much commendable in such a dairy; unfortunately they cannot be considered common; they are rare when compared with the number of people or families keeping cows for commercial purposes. Much labor is misdirected on account of ignorance of the principles involved, consequently traits which are admirable in one place are entirely counteracted by traits which are pernicious. Labor is expended on what may be supposedly right, but is actually wrong. To illustrate this feature, many dairymen groom their cows to clean them and then milk in the stable while the grooming is in progress. Others will go so far as to wear milking suits and then use them for all kinds of dirty work until the milking suits are dirtier than the suits underneath. Aerators are frequently bought to better the quality of the milk, yet seldom washed when used. One of the most common inconsistencies is to take the best care of the milk after it comes from the barn, but in the barn or stable it is exposed to various infectious diseases to which milk is peculiarly susceptible. These are only a few of the numerous shortcomings of the second type of dairies, and are very noticeable to those who have taken the trouble to visit dairies for the purpose of learning where weaknesses exist.

3. What is apparent in the third type of dairies is frequently regarded as impracticable by the majority of dairymen who are accustomed to old methods, the only methods with which they are familiar. As long as this type of dairies is in existence, and most of them are founded upon a business basis, this type cannot be eliminated

without doing greater injustice than would be done were either of the others to be removed, for in this type of dairies is all the progress, all the innovations and all the ideals of high character. Without this type there would be no stimulus to move on.

The barn is usually built in such a manner as to make it possible to flush the floors so as to remove all filth before milking, or a special milking barn is constructed to overcome the filthy accumulations of a stable. A barn specially erected for milking alone savors of expense which the ordinary dairyman cannot afford. This barn will not be considered in this type. A giant effort is therefore made to do away with the stable filth, the obnoxious gases and foul air, by a suitable floor, proper ventilation and lighting. The floor is commonly cement. The cows are carefully groomed at a time when the dust will least interfere with the milk. Dusty foods are not given the cows just before or at the time of milking. The atmosphere of the barn is supposed to be as quiet as it is possible to have it and free from dust. Stalls are so constructed as not to cause unnecessary brushing and crowding. The cows are free from loose hairs and dirt when ready for milking. A tepid water and sponge are used to wash off the udders, the sponge, squeezed, is made to take up any superfluous water remaining on the udders just before milking begins. In this manner the udders remain moist during the milking and thus keep some particles of dirt and dust adherent to them. The milker has clean hands and a clean suit and the teats are practically dry. All pails and cans are subjected to a thorough sterilization. When a can or several pails have been filled in the barn, they are taken to the dairy room, quickly aerated and cooled. Once cooled the milk is kept in this condition until delivered to patrons or ready for utilization in making dairy products. *Milk once pure is easily kept pure for whatever purpose it is designed, and is under absolute control whether for delivery to city patrons or for making into butter or cheese.* The above type represents the highest now in practical use. The results obtained from it are sufficiently great to warrant extra expense and striving for greater perfection.

There are two or three very prominent defects in the system just cited, and many errors in detailed manipulation are conspicuous, otherwise this type may be regarded as model or ideal. The more prominent defects are: first, milking in the barn; second, the keeping of milk too long in the barn before aeration and cooling; third, the care and management of utensils. These, with the minor defects, will be considered later. At this point it seems pertinent to call attention to the attitude which most dairymen should assume towards these ideal systems and dairies.

In most professions, anything which helps to advancement is considered with true reverence by the active and progressive souls of the profession, and those who give little attention to the agents which lead us on generally keep quiet and rest, while their brothers hasten on to absorb the newly demonstrated. It is somewhat different in the dairy profession, since the interests are so varied that the members constituting it cannot agree on mutual advancement. He who is a good butter-maker is unable to convince the producer of milk, upon whom he is obliged to rely for his supply of milk, that both will be greatly benefited by the institution of certain reforms. It is only, therefore, when the handling of milk and milk products has been under the direct charge of the producer himself that any improvement has been made. The producer must know the difficulties of the consumer, butter-maker or cheese-maker, or vice versa, in order that a mutual sympathy may exist. If sympathy and interest may be aroused on both sides, it is possible to secure a satisfactory understanding: if these agents cannot be elicited and only indifference prevail on one side or the other, it is high time relations be brought to a close.

Every improvement which tends to assist the dairyman should be welcome, whether it can be made of practical use at the moment or not. Practical or impractical, one may lead to as great results as the other eventually by means of suggestion and application. It is becoming man to learn as much as he can, use as much as he can, and what cannot be made of immediate utility, reserve for the future. No one thinks of renouncing Christ's philosophical teachings because he cannot live as Christ did; he merely does his utmost to live as Christ lived if he is a man of worth. Our ideals in dairying should be of the highest type capable of man's ingenuity; we should strive for this ideal and not be discouraged if we fall short of it. This ought to be the aim of every dairyman and he ought to get as close to it as he can under his conditions. In this attitude it is possible for him to consider the discussion of typical dairies in their true light and attribute to them their proper significance so far as he is concerned. From them he will learn to improve his own to that extent dictated by his own peculiar circumstances. What one may do another cannot do, accordingly no general discussion

of the subject can be adjusted to exactly fit his case. The author trusts that in the further discussion of this subject he will be rightly interpreted as to his motives and ideas. The purity of milk is dependent upon the milking process itself and its surroundings, for pure milk once obtained, it can be kept comparatively pure for some days and is capable of management according to the will of the dairyman.

The author has aimed by some simple experiments to demonstrate the real significance of what is meant by pure milk and polluted milk. He will call to his aid the work of others to assist in verifying his conclusions. The experiments of the author were carried out under average conditions of dairy operations and the results may readily be taken as average results. Those quoted from other authors or investigators will be cited in sufficient detail to convey a fair understanding.

A sterile glass dish one-half inch in depth and three and one-half inches in diameter, with an overlapping cover, was exposed in the air of the milking stable for five minutes. After the exposure, nutrient gelatin, a suitable food for most bacteria, was added to the dish and allowed to solidify. The dish was then placed away at the ordinary room temperature of the laboratory that the life in the dust which fell into the uncovered sterile dish for five minutes might develop. Each germ present usually grows into a colony which may be readily seen with the naked eye or by means of a very low magnifying glass. When these colonies are counted a fair idea is obtained of the number of bacteria present in the dust. However, many fine particles of dust do not dissolve in this gelatin, a fact which is easily determined by the microscope, so that only a fraction of the entire number of micro-organisms is represented. The germs on the surface may grow into colonies, but those that are contained within the particle are removed from the food material, hence have no opportunity for development. Remembering the above description and explanation it will be readily understood how the number of bacteria is obtained and how inadequate is this crude method. Other methods more exact are in use, but are more technical and thus are not so desirable for the present purpose.

Several exposures were made in the open air of the stable and the number of colonies developing in each plate, or the approximate number of micro-organisms present in the dust of each plate, exposed for five minutes, varies from twelve to eighteen thousand in round numbers. These exposures were made when milking was in progress. The ordinary milk pail is about twelve times as large at the top as is the little glass dish mentioned above, accordingly the approximate number of micro-organisms falling into the pail exposed to the stable dust for five minutes would be twelve times as great, or from one hundred forty-four hundred or fourteen thousand four hundred to twenty thousand six hundred.

Had this estimation been made at the time of feeding dusty foods, or when bedding the cows with straw, or when the cows were entering the stable, the number would have been markedly increased. It was not the purpose of the writer at the time to take up all the possibilities incident in the management of a dairy stable, for he is reserving such investigation for a future time. It may be confidently stated that a few estimations made at such a time as above mentioned indicate what has been demonstrated by Hesse, that the increase is very great.

Aside from the probability that milk setting in a stable absorbs obnoxious gases, the importance of the germ content of the air of the cow stable is readily seen by these simple experiments. As a general statement it may be safe to say that the smaller the number of germs in the milk the better will be its keeping qualities. If, as is often done, the milk is allowed to stand in the pail exposed to the air of the stable for thirty minutes the number would be six times as great, or varying from eighty-six thousand four hundred to one million two hundred thirty-six thousand. Even so far as the dust of the stable air is concerned, every minute of time is very significant. Had the dust arising from feeding, or bedding, or grooming, or, in short, any disturbing influence, been added, what might occur is almost beyond prediction.

A single cow's hair has its rôle to play. Estimations have been made of the germ life present on comparatively clean hairs taken from cows. There was no desire to take hairs which had little lumps of dung on, for no satisfactory idea could be obtained in this manner. Hairs were secured from the side and top of the cow and at a distance from manurial patches of richness. Our estimates demonstrate that from six to seven hundred micro-organisms, approximately, may be found on what may be regarded as clean hairs.

If by means of one, two, three or four thicknesses of cheese cloth, or by an additional layer of cotton wool, the diaryman removes the hairs from the milk, he thinks he has removed the evil. It would be just as rational to secure a bunch of hairs from a cow,

place them on the strainer and pour the milk over them, and then conclude that none of the filth on their surfaces found its way into the strained milk. The hair on the strainer is simply washed of all its filth and bacteria, which in turn find their way into the strained milk. After the hair has been washed thoroughly, its presence in milk cannot be considered so undesirable. Many people are sickened because a hair is found in the milk, but are able to withstand the formidable appearance of an eighth of an inch of filth at the bottom of the glass.

It is not an uncommon sight to see a handful of hair on a strainer. The importance of grooming in removing the loose hairs from the body of the cow, and the coarse dirt, as well as the necessity of keeping the udder damp while milking, may be easily grasped in this connection.

Particles of manure or dirt are equally rich in microbial life. From two or three millions to seventy or eighty millions of micro-organisms have been found in one gram (fifteen grains) of dung or stable dirt. Renk, in his investigations of milk delivered to cities, points out that most of the dirt found in milk is composed of dung and as much as six grains of dry dirt has been found in each quart estimated on a basis of eighty per cent water content. Other estimations are much lower, but it is not difficult to ascertain the germ content by this means. Dirt falling into milk is partially dissolved and much of it is held in very fine suspension, consequently when a layer of black filth is found at the bottom of a can, we form only an approximately accurate opinion of the condition of the milk.

Many, perhaps more than two-thirds, dairymen furnish milk which is rich in the deposits of filth at the bottom when allowed to stand. Even nearly all of the third remaining cannot boast their milk absolutely free from such a deposit. Accordingly, our ideas of cleanliness must remain somewhat stunted in the face of this deplorable condition and we are forced to go on in the knowledge of the risks involved with little hope of immediate change. A study of straw and fine filamentous substances floating about the barn or stable, especially when the bedding or hay is disturbed, yield practically the same results as obtained from the study of hair. In this popular account it will be unnecessary to repeat what may be found in the previous discussion of cow hairs. However, this item cannot be disregarded or considered of less importance than many others, for it doubtless has a great significance in the securing of pure milks. The author places straws and fine filamentous substances on the same footing as hairs, such as indicated by his experiments.

There can be no greater problem to solve in connection with the building of a dairy barn under the present systems than the selection of a suitable stall. Eliminating all other essentials than that of cleanliness, this alone would be sufficient to make the selection exceedingly precarious. Cleanliness is the only feature which will be of any interest in this review, for upon this is based the relation of the stall to pure milks.

It is easily guessed that the dirt found on the sides of a stall is only a composition of what has been analyzed in the preceding paragraphs, existing usually in a dried state. The cows rub against the stalls in scratching themselves and always leave more or less dust and dirt behind them. Their tails are switching about, scattering filth in every direction, the stalls are the most common obstacle in the way and therefore receive the major part of the filth. The dust is constantly settling in the stable and finding lodgment on the sides of the stalls or in the crevices. When the milker approaches and crowds into the stall, or the animal happens to strike the stall, a cloud of invisible dust particles is aroused, the atmosphere becomes loaded with unwholesome material and it becomes impossible to obtain clean milk. Not infrequently the milker so manipulates himself and pail in pushing his way into the stall that comparatively large pieces of this dried filth on the stall find their way into the pail. Again, it is customary after the milker sits down to the cow to move about more or less, and if the stall is a complete partition his back is in contact constantly, stirring up the adherent dirt.

A half partition is preferable to a full partition stall, and no stall is preferable to a half partition stall, so far as cleanliness is concerned, under ordinary conditions. It may be just as well to brush against a stall as against another cow, but either should be avoided. If a half stall could be used, made from gas piping and kept perfectly clean, the danger arising from it would be reduced to the minimum, yet far from perfection. It is an exceedingly difficult matter to construct a stall which will meet other requirements and at the same time meet the requirement of cleanliness.

The floor should be damp, but perfectly clean and free from bedding during milking. A dirt floor cannot be made clean, and a plank floor is very difficultly cleaned. The cement or asphalt floor is the best suited to cleanliness, but these must be flushed

before milking, otherwise the filth upon the floor may in one way or another find its entrance to the milk. If the floor is dry and filth is present, or if loose straw or other bedding in a dry state is under the feet of the animal, dust of the worst type must arise due to the movement of the feet of the milker and the animal. It is the practice in some places to use sawdust or other material on a cement floor to prevent slipping. If properly managed this could perhaps be made useful, but the man who uses it will have to be a very conscientious man to keep it in a fit condition. Such methods are resorted to in some of our ideal plants, but frequently what is accomplished in one direction is overcome in another by a false step. It is much like the surgeon who is very particular about asepsis in surgery, in the absence of germs, and has everything aseptic except his scalpel. It is not advisable or economical, after going to great expense, to undo what has been done by a single false step. It is true conditions will not be so bad, something will be gained, but by carrying the scheme through there is much to be gained in several ways.

No measure taken in efforts to obtain pure milk appeals to the mind with such force as personal cleanliness of the milker. Although the number of micro-organisms from this source is doubtless much smaller than from other sources, the cleanliness of the milker is indicative of the other movements in the stable and dairy, and the possibility of conveying infection is reduced both by his cleanliness and soundness. The milker must be both a clean man and a sound man, otherwise he is unfit for milking. The foregoing are objective qualifications; subjectively he must be a very conscientious individual. These qualities, in addition to gentleness and pliability of the hands, make a woman a far more suitable person for milking. The man who will come from the field with dirty hands and dirty clothes, and proceed to milk without washing or taking off his filthy outer coverings, is certainly no criterion to follow; nor is he, who simply adds a white duck suit in which to feed the pigs slop, clean the stables and then milk, a much superior being. A man who milks should wash his hands before milking and after milking each cow, and should wear a clean suit for milking purposes only. It is nauseating to see a woman working over a meal with a filthy dress or unclean hands, why should it not be nauseating to behold a milker in filth laboring over the milk we are to drink?

There is always danger of individuals working with milk carrying disease-producing micro-organisms to the milk. Milk is a very good food for these micro-organisms, therefore it is more to be feared in this respect than other foods. If by any chance the hands should be moistened with saliva, or the milker come in contact with some infectious disease or should unknowingly have an infectious disease lurking about him, he at once becomes an agent of disease dissemination and a source of danger to all those who may use the milk coming from his hands. There can be no source of disease dissemination so vitally important, except a patient, as the milker of cows. He needs careful supervision through his own inspection or should be made subject to the inspection of someone else who is competent to judge.

Many models have been presented to dairymen for the construction of a suitable milk pail. The one principle, the decrease in the amount of surface exposed, is correct, in that it lessens the possibility of contamination to some extent, but greatly increases the difficulties of the milker. This fact needs no expansion, for it is obvious that an increase of milk surface exposed to the contaminating influences of the stable renders the milk more liable to contaminations. Strainers of various kinds can have little influence other than restraining the entrance of coarse particles of insoluble dirt and straws which will have their surfaces thoroughly washed by the impinging streams of milk. All that is obnoxious is therefore carried through the strainer into the milk. The gain will be simply the eradication of unsightly objects in the milk. The ordinary milk strainers have little significance in cleansing milk from a cow.

Whatever the nature of the milk pail may be, it is essential that it be properly cleaned and sterilized. In some of our bacteriological studies of milk pails supposedly ready for receiving milk, we have been surprised to find not only the seams in the pail rich in bacteria, but also the surface itself. From five hundred thousand to fifty million per gram (15 grains) have been estimated in material taken from the corners of milk pails which had received considerable attention in cleaning, and on the surface several thousand per square inch. In some moisture left in the pail which had been put away and had stood for six hours, the number of micro-organisms reached sixty thousand to three hundred thousand per cubic centimeter (about 20 drops). The practice of rinsing pails and putting them away till the next milking time is not an uncommon practice. The results detailed above place this undesirable method or operation in its true light, and they should not be passed over without yielding a careful consideration of the milk pail problems.

The carelessness with which milk pails are handled is a matter of no little moment. In the dairy they may be cleaned perfectly, but what is gained if they are taken to the barn or stable and exposed to the dust through bedding and feeding and sometimes cleaning. It has been shown in connection with the study of the stable dust, how pernicious such a practice is in inoculating the pail with millions of obnoxious bacteria. Under the discussion of aerators, coolers and cans, more will be said pertinent to this subject.

We are now ready to make some estimates of the number of bacteria reaching the milk during the process of milking. For this determination, plates were exposed next to the pail for different periods of time. The conditions under which these exposures were made may be regarded as slightly above the average. The number of bacteria developing in the plates range from four thousand to eighty thousand during one minute of time, or the number of bacteria falling into a twelve quart pail during one minute of time would be in round numbers from forty-eight to seven hundred twenty thousands. Allowing five minutes for milking, the number would be multiplied by five, or from two hundred forty thousand to three millions six hundred thousands. The author has made independent estimates as high as nine millions. In this rough estimate, the fact that only a fraction of the real number of bacteria find their way into the milk can be profitably taken into consideration. This inexactness is due to the insolubility of particles of dirt and dung in the gelatin and to our inability to make a correct count of the number of bacteria on hairs, shreds and substances of like nature. The great variation in the number of bacteria is principally due to the cleanliness of the cow, some are much cleaner than others under ordinary conditions. It has not been possible for us to make an estimate of the number of bacteria getting into the milk in the first or third classes or types mentioned previously. What we have gives some idea of a type between the first and second, but nearer the second.

There is no factor so important in handling milk as the milking process itself, for with a little care much filth may be avoided and a comparatively clean milk may be obtained—as clean as it is possible under the circumstances. At this point all of the agents which have been discussed are centered,—the dust of the barn or stable, the hair of the cow, particles of dung and dirt, shreds of straw or other substances, the care of the stable floor, the cleanliness of the milker's hands and clothes, and the condition of the pail, all exert a greater or less influence upon the act of milking. Here will be found failure or success in dairy operations. If a dairyman can control his work satisfactorily thus far, the steps remaining ought to be easily managed. Again, *a milk comparatively free from bacteria or other micro-organisms to start with may be easily controlled thereafter.*

It is quite a difficult matter to secure a milk from the udder of the cow free from bacteria. Bolley and Ward have demonstrated this, but it is possible to obtain a milk that is practically pure, and usually will not readily undergo change. In this laboratory, the author drew from thirty different quarters of cows' udders by means of sterile flasks and milk tubes, after milking out a little of the fore milk, thirty different samples, thirteen of which at the end of six months placed at the temperature of the living room had not undergone any appreciable change. This does not mean that they were necessarily germ free, but that the germs did not act upon the milk to materially change it. It is the experience of those who have made a special study of milk taken from the udders of cows that many of the bacteria found in the udders have no influence upon the milk. For practical dairying this may be disregarded largely, as far as the keeping qualities of the milk are concerned, but should not be lost sight of when any obnoxious germ is causing trouble in the dairy.

Before leaving the stable, it may be well to call attention to a habit which some dairymen or milk-producers have of permitting decaying substances to remain about the barn or stable. I have seen decomposing flesh, rotten beet pulp and other such substances in or within reach of the milking stable. Aside from the odors which emanate from decomposing substances, and which may be absorbed by the milk, there is a grave chance of some of the micro-organisms of decomposition finding their way into the milk and producing intensely toxic or poisonous products. Carelessness of this sort may be fittingly regarded as criminal.

What the true significance of aeration of milk may be is a question difficult to answer at the present time. However, when we inhale the foul odors coming from the milk during the process of aeration, the value seems to be apparent. When milk is passing through the separator, the same foul air is noticeable, coming from the delivery tubes. These facts in connection with the experience of practical dairymen indicate that this step is one of great value, yet there are those who maintain that the mere aeration of milk does not enhance its value. Perhaps in not the far distant

future, this perplexing problem may receive some light which will help it to a satisfactory solution. At the present time, those who furnish us our best milks submit them to careful aeration, believing that by this act the quality of milk is greatly improved. The usual methods of aeration are very imperfect. They fail to bring all the parts of the milk in contact with the air, therefore a good share of it is not aerated. If aeration is to be complete, an apparatus is necessary which will produce the most perfect film or finest spray, for it cannot be expected that the air will enter very deeply into milk when exposed for only a second or two.. If aeration is as desirable as is generally supposed, the ordinary management of milk must be very imperfect.

Concerning the importance of cooling milk, there can be no doubt. The warm milk as it comes from the cow furnishes a most highly desirable temperature for the development and multiplication of bacteria. In the summer time, several hours are required to cool the milk down to the surrounding temperature, which in turn may of itself be very suitable for the growth of bacteria. Consequently, there is furnished in connection with the milk as food, the most favorable temperature from the time the milk leaves the cow until it is either changed or consumed. In the winter time, even if the atmosphere is very cold, much time is consumed before the warm milk coming from the cow is cooled down to such a degree that the multiplication of bacteria is checked. If a sample of milk be taken and divided so that half be placed in a refrigerator and the other half at the ordinary room temperature, there will be found a great difference in the rapidity of bacterial multiplication. In the estimation of the number of bacteria in the sample placed in an ordinary refrigerator with a temperature of 60 degrees F., and in the sample placed in the room at about 75 degrees to 80 degrees F., the writer found that the rate of increase in the room was from fifty to one hundred times greater than in the refrigerator. The cooling of milk immediately after milking is to a large extent the factor which determines its keeping qualities, for the temperature may be reduced to such a low degree that all bacterial development is inhibited, but this should not be interpreted as a cleansing agent, for the bacteria remain alive, although not multiplying, and the filth is still present. It controls but does not eliminate; it checks but does not destroy.

What per cent of milk producers think it worth while to cool milk? Knowing what it does and how useful it is, so little attention is paid to it in ordinary dairy pursuits that it practically remains an unknown feature in dairy operations. Those milk producers for whom it would be most useful do not utilize a cooler, and many times when a cooler is used it is maintained in such a filthy condition that it were better to resort to the simple device of the dipper or some apparatus which is easily cleaned. Many object to a cooler that exposes the milk to a very extensive surface because of contamination from the air. This, however, is a serious fallacy, for if the room in which the milk is cooled be properly cleaned, this source of infection need not be taken into consideration. Milk that is cooled over a large surface exposed to the influence of ice is almost instantaneously rendered unfit for germ growth, but following the customs usually employed, a can is first filled, then placed in a vat of cold water, perhaps iced, and stirred until cooled. Too much time elapses in the prosecution of this method, hence it cannot be regarded as the most desirable. Quickness is important in this operation.

I have already called attention to the necessity of having clean utensils in connection with our discussion of the milk pail. Cleanliness, of course, is the uppermost thought of a successful dairyman's mind, but this does not explain why it has become so generally the practice to make use of milk cans in carrying sour milk and whey from the factory to the stable and then after emptying them, simply rinsing them out with cold water in preparation for the fresh milk. It is not strange under these circumstances that the milk sours in a few hours' time. It is possible to carry sour milk in a can and clean the can sufficiently, so that it will not have any influence upon the sweet milk introduced. Care, however, will have to be exercised in producing perfect cleanliness. The same may be said of the cooler or the aerator or any milk receptacle. To use a receptacle that is not perfectly cleaned is not only dangerous, but materially reduces the value of the milk. How the cleaning should be performed will be described in another place.

The water supply to a dairy has no little influence upon the keeping qualities of milk and its products. This is true of ice also. Many samples of water and ice have been examined in this laboratory and it has been found that the germ content of either is capable of producing a decided effect upon dairy products. Some sample dairy waters have been determined to possess several hundred thousand bacteria per c. c. (one-thirtieth of an ounce). Such water as this cannot fail in yielding unsatis-

factory results. It is therefore desirable to know the water supply and if necessary sterilize it before it comes in contact with milk or milk products. It is not infrequent that disease producing germs are found in such waters and there is a chance of conveying some infectious disease by their use. Ice contains germs, sometimes in as large numbers as water. Often the ice is secured from some dirty pool and in addition to an extremely large number of bacteria, it carries with it a great mass of organic matter. It is really a pernicious habit to add either water or ice from an unknown source or the quality of which is unknown, to milk.

The use of preservatives in milk is assuming vast significance because of the common practice of employing them in milk designed for human consumption. It is not our purpose to name the various kinds on the market nor to consider their germicidal value. The use of these preservatives promiscuously is illegal, is deceitful, is dishonorable and is criminal. They in no way have any relation to pure milk supply other than their elimination.

The hygienic aspect of the question of pure milk is exceedingly great, for in it is included the conveyance of disease through milk and the diseases arising from filth. Of the former, many diseases are actually known to be conveyed by milk, such as typhoid fever, tuberculosis, cholera; of the latter, typhoid fever, gastro-enteritis and other intestinal disorders. In the years 1883 and 1884 three hundred cases of cheese poisoning occurred in Michigan. Every year witnesses a large number of cases of milk poisoning or poisoning from foods made from milk. When all these cases of cheese and milk poisoning are enumerated in Michigan alone the number is large. Inasmuch as it is the result of carelessness, it is high time that some consideration be given to the securing of milk free from disease elements. How many deaths from tuberculosis, typhoid fever, cholera infantum or other choleraic troubles may be traced to impure milk, it is impossible to say, but if cursory judgment may approximate the truth, the number must be large. Deliberate carelessness is never excusable, consequently the crude, indifferent methods used in producing milk are not pardonable.

What economic value the proposition of pure milk has must bear a secondary relation. If a manufacturing plant fails to make a profit or even cost, it at once ceases operation. The manufacturers do not usually condemn the people because they do not buy their products, they rather admit their inefficiency in meeting prices of the same grade of goods. While in some respects the milk producer does not simulate the manufacturer, yet in large part he does and therefore must recognize his place among other producers. He must create a market for his class of goods or compete with the common producers. This last class is very plentiful and there is little to be gained in such competition, but the man who has the combination of energy, intelligence and capital can easily surpass the common class of producers and create a new brand of his own. He will establish a market for his goods; once established, there will be no serious trouble in getting rid of his goods. However, if he once begins to produce cheap milk, the dairyman will find it a difficult matter to change unless he finds a new market. The writer does not claim that he can produce milk at two and one-half cents per quart and sell it for five or six cents to the retail trade according to proper methods; but he believes that a pure milk may be secured for an additional and maximal cost of one cent per quart over the present cost of average dairies which furnish milk to the retail trade and can reduce that expense above the average dairies to the fraction of one cent per quart in the preparation of milk for butter and cheese.

With the foregoing fact and conditions in mind, it is the purpose of the author to offer a suggestive scheme founded upon exact principles underlying dairy work and anticipative of future development. What may be promulgated in such a plan may not be of immediate applicability, but he who is desirous of progressing will be able to keep the ideas in mind, or some similar and equally desirable, that he may have some high standard toward which to labor. Science offers sufficient demonstrated data at the present time to render improvements advisable and secure, and these data the writer hopes to make applicable. These must not be interpreted as within the immediate attainment of every milk producer, for such would not be true. Each milk producer has a set of conditions and circumstances with which he must accord and he will be able to get rid of them by a gradual change towards a high ideal, altering his conditions and circumstances of the present for conditions and circumstances better adapted to a higher type. That individual who ridicules better models than his own by regarding them as impracticable and impossible only bars all opportunities for his own betterment; he will die in the same suit of clothes of intelligence he put on when a mere boy.

In this bulletin there will be no attempt to follow the milk after it has been obtained in a pure form for consumption as milk, butter or cheese.

The inspection of the cow which produces the milk is the first important step. Of course her food should be a part of this inspection, but a knowledge of what the food should be or should not be is fairly understood now, or if not, a knowledge of it may be easily acquired. Disregarding any further consideration of the food, the cow herself is the machine which should be carefully inspected every two weeks by a competent man, or if the proprietor works about the cows daily, he, if he understands the animal thoroughly, will be able to assume the duties of an inspector daily. The inspection of cows should not be left to milkers, for they are usually too indifferent to observe the small variations in an animal which are easily detected by the owner.

Although our knowledge is not sufficient to say that every sick or abnormal animal secretes a dangerous milk, yet we do know that some diseases yield through their influence upon the animal economy an abnormal milk. If the disease is acute, it would be far better to avoid any risk, to suspend the use of the milk for the period of the disease; if the disease is chronic, it were better to not use the milk until some one competent could pass upon it. To avoid the possibility of conveying tuberculosis to man or animals through the milk, every milk producer should subject his herd to a tuberculin test, not only for his own benefit economically and hygienically, but for the benefit of others.

The stable should be properly ventilated, lighted and drained. It is not necessary to make a stable which will involve thousands of dollars of expense; a common ordinary stable such as many of you have will do; in most of the stables in use, the factors mentioned above, especially ventilation and lighting, are sufficient for the health of the animal. The old style of barn has cracks and knot-holes and windows, all of which add to the ventilation and light. Drainage is too frequently disregarded and the result is that much decomposition is constantly in progress, vitiating the air and proving very detrimental to the well being of the animal. It does not seem feasible to recommend the construction of barns which will meet all the requirements of a pure milk supply. This idea is barred out largely for the reason that where many cows are brought together in a stable, it becomes impossible to keep the stable in a condition of absolute cleanliness. There are the stalls, the gutters and in most cases, feed boxes and other equipments, all of which render cleanliness complicated and uncertain.

To obviate these difficulties which are always associated with the stable, the writer believes that a milking room of a size sufficient to meet the requirements of a herd, into which the cows, one, two, or three at a time, may be brought for milking, would be the most desirable and is the only means by which a pure milk may be obtained. This room would be provided with water, conveniently located and prepared for not only keeping the room in an absolutely cleanly condition, but for sponging off the udders of the cows before milking. The cows, when brought into the room, shall have been groomed previously, and so placed after entering the room that there will be no rubbing against each other or necessitating the milker to brush against them. This procedure would remove the cows and the milk from the dust of the stable and the dirt coming from the stall, the bedding, the food and other environments, and would place them where the air is comparatively free from dust and the filth from the stable. The dirt from the udder and hairs would be overcome by sponging the udder and flank with luke-warm water in such a manner as to prevent drippings, and by keeping the udder moist while milking. If the size of the herd would warrant it, one man could look after the leading of the cows back and forth and the grooming, and the milker, dressed in a clean suit made purposely for his work, would attend to the milking and the milk only.

I am aware that when this method is first carried into operation there will probably be a falling off in the secretion of milk and butter fat, but after a time, as Mr. Johnson demonstrated, by gentle treatment, the cow will become accustomed to the change and will resume the normal secretion of milk. This is to be expected of the peculiar nature of the cow. She is very sensitive to changes, but is also very susceptible to gentle training.

The removal of the cow from the stable environments into a pure air, and the dampening of the udder and milking into a sterilized pail in such a manner as would be entirely feasible and practicable, has been demonstrated in a few simple experiments by the author. The pail used in these experiments was steamed ten minutes, the cow was led out of the barn into the open air at a time when the ground was damp, thus eliminating dust in the air, her udder was sponged off and remained damp during the milking, but in each case she had not been groomed. Samples were then taken, after milking, from the pail, and samples also were taken from the pails, at the same time, of the regular milkers. These samples were placed in a warm room at about 70 degrees

F. and watched each day until some perceptible change was noticed in the milk. The time from the milking of the cow was then noted and the results compared. Four tests of this kind were made. The samples from the pails of the regular milkers invariably soured within forty-eight to seventy-two hours after milking; the test samples kept nine, eleven, twelve and twenty-eight days before any change in the milk was noticeable. Had the milk been cooled and kept at a cold temperature, it would doubtless have kept much longer. In the estimation of the number of germs in the two series of samples, the numbers were of about the same ratio as the days of keeping. There was nothing in carrying out this experiment that could be regarded as impracticable or that would increase the expense to any great extent. The author, by advocating a clean milking room in place of the open air, believes that he is making the process of milking more convenient and better adapted to the handling of a large herd. At the same time, bad weather and dusty weather will not have to be contended with, the cow will be more easily managed, the water will be at hand, the milker can keep more cleanly and the surroundings will be better suited for carrying on the work.

By the side of the milking room there should be a milk-receiving room. In this should be an aerator, cooler and tubs with iced water. This would permit the immediate aeration and cooling of the milk and the possibility of keeping it cold from the very minute that each cow was milked. The aerator and cooler, and can and ice vat, could be so arranged that the milker could pour the milk from each cow through a spout extending to the milking room and it would find its way over the aerator, cooler and into the can placed in the vat of iced water. The milk receiving room would be shut off from intrusion, would be kept perfectly clean and would be entered only by the milker with a clean uniform when it was necessary. Milk thus obtained would probably keep several days at room temperature and could be made to keep for a long period if continued in the iced vats. It will probably be admitted that such milk would be delicious for consumption and if made into butter or cheese would be absolutely under the control of the butter-maker or cheese-maker and, other things being equal, would yield uniform products of each class.

It is not our purpose to carry this discussion farther at this time. If such milk could not be properly utilized after once secured, in the creameries, home dairies or cheese factories, it would not be the fault of the milk in any case, but of the operator.

Again I repeat that this plan or system is thrown out as a suggestion and an ideal toward which milk producers should strive. I have no doubt that many of the details could be improved when put into operation, but in the main, I feel quite confident that it is correct and that it will yield results beyond the expectation of the dairyman.

Mr. Ira O. Johnson of Grand Rapids has carried out experimentally the scheme suggested in the preceding pages. It consisted in removing two cows from the herd to a milking room having a cement floor and kept in a very clean condition. The cows were tied to the side of the room and milked according to the methods which he employs in the barn. One of his regular milkers did the work just as he was accustomed to doing it in the barn. The cows had been groomed previously, as is Mr. Johnson's habit, and just before milking the udders of the cows were washed off thoroughly and all the surplus water taken up with a dry, clean towel. The hands of the milker were clean and he wore a clean suit of clothes employed especially for milking purposes. The pails were cleansed with warm water and then steamed. When milked, the milk was cooled down and a sample taken in an Arnold bottle, which was plugged with cotton wool. The milk was kept cold from the time of cooling down to the time of shipping to this laboratory. Boxes containing ice were used for shipment and usually the milk arrived at the laboratory in a very good condition.

Along with the above sample of milk was sent one handled in the same way with this exception,—it came from the milk which was milked in the barn. The object of this sample was to contrast it with that produced in the milking room. The floor of Mr. Johnson's stable is cemented and he keeps it covered constantly with land plaster. The walls of the stables are whitewashed and kept very clean by occasional thorough washing. At the time of this experiment there was no bedding in the stalls and the amount of food handled in the stables was small compared with that of the winter season. The milking was performed in exactly the same way as in the milking room.

When the milking room is contrasted with such a stable, the advantage will evidently not be so pronounced as over the ordinary stables.

My work with ordinary stables had been done previously and independent of this experiment conducted at Mr. Johnson's place, but I think the results may be safely used for comparison.

The following table will give the germ content of the various samples studied:

	Milk drawn in milking room. No. of bacteria per cc.	*Milk drawn in Johnson's stable.* No. of bacteria per cc.	*Milk drawn under ordinary conditions.* No. of bacteria per cc.
Sample I	1,180	2,160	30,100
Sample II	240	960	1,516,900
Sample III	240	1,680	1,225,000
Sample IV	320	480	474,250
Sample V	400	640	1,260,000
Sample VI	400	1,280	210,000
Sample VII	320	1,760	
Sample VIII	320	4,140	
Sample IX	120	32,200	

Only six samples were studied under ordinary conditions.

This table represents the germ content of the milk which has stood under refrigerator conditions for twenty-four hours. The first two columns would have an average temperature of about 13 degrees C. and the last column 15 degrees C.

The milk from the milking room had its keeping value enhanced slightly over that from Mr. Johnson's stable. There is no guide which is absolute in designating milk when it is changed. In the one case it may be an acid change and in the other a peptonization of the casein or any of the numerous possible changes in milk. However, so far as the eye could detect, the milking-room milk would keep twenty-four to thirty-six hours, sometimes three to four days longer, than the milk which came from Mr. Johnson's stables. The milk which came from Mr. Johnson's stables kept on the average about nine days before any change was noticeable to the eye. This was five and six days longer than the keeping of the milk from an ordinary stable.

The milk from the ordinary stable generally produced the lactic acid loppered condition, while the milk coming from Mr. Johnson's place in no instance produced solid lopper. This would indicate that while the pure milk would be much more easily handled and would have many advantages over ordinary milk, it would require greater knowledge and skill in securing the desired results. A starter would be absolutely necessary in the making of butter and cheese.

As to the practicability of the milking-room scheme, I may add that Mr. Johnson thinks that it is feasible and desirable, but believes that it does not lie within the power of every man to carry out the details. An extended knowledge of milk management and of the sciences upon which it is founded are essential to a conscientious execution of the plan. This we admit to be true and at the same time believe that no successful dairying can be accomplished by those ignorant of and unskilled in the dairy business.

I wish to add my appreciation of Mr. Johnson's efforts in carrying out the foregoing experiment and of many suggestions from him.

Before closing I wish to acknowledge my sincere appreciation of the suggestions and criticisms, some of which have been embodied or discussed in the foregoing, from some of the leading milk producers, milk dealers, creamery men and cheese-makers in the State of Michigan, as well as Mr. Busck of the Copenhagen Milk Supply Company, and Mr. Sorensen of the Manchester (England) Pure Milk Supply Company.

CHARLES E. MARSHALL.

Agricultural College, Mich., June 20, 1900.

GASSY CURD AND CHEESE.

BY C. E. MARSHALL.

Bulletin 183.—Bacteriological Department.

Already much has been written on this subject by Russell,[1] Bolley and Hall,[2] Moore and Ward,[3] Jensen,[4] Freudenreich[5] and Weigmann,[6] but specific cases must always add to the interest of the matter and contribute to the fund of knowledge now at hand. The commercial importance of the theme can be no greater elsewhere than in Michigan, where the cheese is peculiarly adapted to gas formation on account of the moisture, acidity and other striking qualities of the Michigan cheese. The loss accruing from this trouble alone must be exceedingly great to the cheese-makers of Michigan if we may judge from the number of reports coming to our notice in which gas is held up as the principal agent of most failures.

It is understood by all cheese-makers that the cause is traceable to micro-organisms and that there is no specific individual species or specific gas which will account for every case. The micro-organisms producing gases are really more numerous as regards species than the kinds of gases produced. Perhaps carbonic acid gas and hydrogen are the most common gases found, yet there is every indication that many more are created, some of which have been detected chemically and others are known only by their odoriferous characteristics.

What causes one milk to result in gaseous curd or cheese and another to remain in a satisfactory condition is readily attributable to the distribution of this class of bacteria which usually have their home in filth, such as is found about a cow stable. Occasionally such a germ may find its way into the milk-duct, yet it is seldom. Bolley[7] states that no gas-producing germ was found out of sixteen isolated from milk taken from the udder under sterile conditions. Ward[8] finds very few bacteria in the interior of the udder, which have any influence on the milk and further suggests that this does not preclude the possible entrance of obnoxious bacteria. On the other hand the author has frequently met with gas-producing or ærogenic bacteria in the study of filth in connection with "pure milk supply." It is also true that such micro-organisms may be found commonly in milk, but fortunately for the cheese-maker they are controlled by the ascendency of other micro-organisms which hold them in check. To seek the origin of the trouble we must return to the ever-present filth. What has been said in regard to pure milk supply is eminently fitting to this case, and the cheese-maker will profit through the persistent care of the milk producer.

It was during the short dairy course of 1898 that a marked inflation of the curd in the vat was noticed. I undertook to isolate the offending cause. This was accomplished, after a series of inoculations in milk-tubes had been made, then, plating in ordinary gelatin, neutral in reaction to litmus. The suspected germ gave rise to numerous colonies, which could be easily isolated from the other colonies present because of the rapidity of their development. Repeated plating was resorted to, that purity of isolation might be satisfactorily established. The germ thus obtained was capable of producing an abundance of gas in milk during a very short period if placed in a suitable temperature.

THE HISTORY OF THE BACILLUS WHICH SIMULATES THE BACILLUS COLI COMMUNIS.

I wish to consider in recording the actions of this bacillus, its relation to the bacillus coli communis and also to the micro-organism isolated by Moore and Ward in this same connection. In order to verify the influence of this bacillus upon the making of cheese, a starter was made to take the place of the ordinary lactic acid starter used in bringing the milk up to its proper acidity. It was found that

the required acidity was longer delayed and that it did not respond with readiness to the usual management of the lactic acid starter. This was experienced the day the inflation of the curd was first noticed. Upon the addition of the rennet with the formation of the curd, the spongy condition appeared. In a separate vat in which there was none of this "gassy" starter, the curd was compact and contained as few gas holes as commonly present. This indicated conclusively that the causal agent of this specific case of gassy curd was isolated.

Our next effort was to ascertain the rapidity with which this bacillus was able to produce gas. For this purpose a glass tube an inch in diameter was bent into a U form, making the arms about eighteen inches to two feet in length. One arm was then hermetically sealed at the end and drawn out to a fine point to facilitate the adjustment of a rubber tube later in the process. This tube was then so filled with milk that only the hermetically sealed end or arm contained milk, leaving the other to receive the milk on the formation of gas. After plugging the open end with cotton wool and sterilizing in the steam bath as usual, the tube was inoculated and placed at

Fig. 1.

the room temperature (70 degrees F.). Gas was very noticable in twenty-four hours, but from twenty-four hours after inoculation to seventy-two hours after inoculation, gas elimination was very rapid, so that the amount formed was sufficient to nearly press the milk out of the closed end of the tube. Fig. 1 illustrates this fermentation. This operation was repeated several times with uniform results. Precipitation of the casein occurred in no case until several days after inoculation, yet the milk was markedly acid, falling short of sufficient to throw down the casein. When these tubes were placed in an incubator at 37½ degrees C. (98 degrees F.), within eighteen to twenty-four hours the maximum (about) amount of gas was produced and the casein also precipitated. This points to very rapid work on the part of this microorganism at the time when the milk is warmed to hasten the necessary amount of acidity, and explains the rapid formation of gas in the curd. Upon testing the acidity of a milk culture which had stood for twenty-six days, using phenol-phthalein as indicator, there was .29 per cent acid calculated as lactic acid. Upon adding litmus to milk cultures the reaction was acid at first and continued to remain acid for six

weeks, when the reaction changed to alkaline. This peculiar behavior, I am inclined to think, probably explains the behavior of cheese which at first does not possess any marked taint, but upon standing the disagreeableness of the odor becomes pronounced. Either there is not sufficient acid maintained to check other micro-organisms of the saprophytic class from instituting slight decomposition of the casein, or this germ itself, grown under conditions which furnish an abundance of nitrogenous food but little carbohydrates in the form of lactose, gives rise to odoriferous products. I am inclined to the latter belief because of the fact that at first this germ produces no unpleasant odors when cultivated in the presence of carbohydrates, but after the carbohydrate fermentation ceases there is perceptible a distinct unpleasant odor. There could not be detected, however, any proteolytic action. Qualitative tests made for alcohol and acetic acid resulted in a failure to detect even traces when the bacillus was cultivated in milk cultures; lactic acid seemed to be the principal stable product. The acidity was not materially reduced by distillation and then making up the amount remaining in flask to original amount by the addition of water. Lactic acid was also found in glucose bouillon cultures.

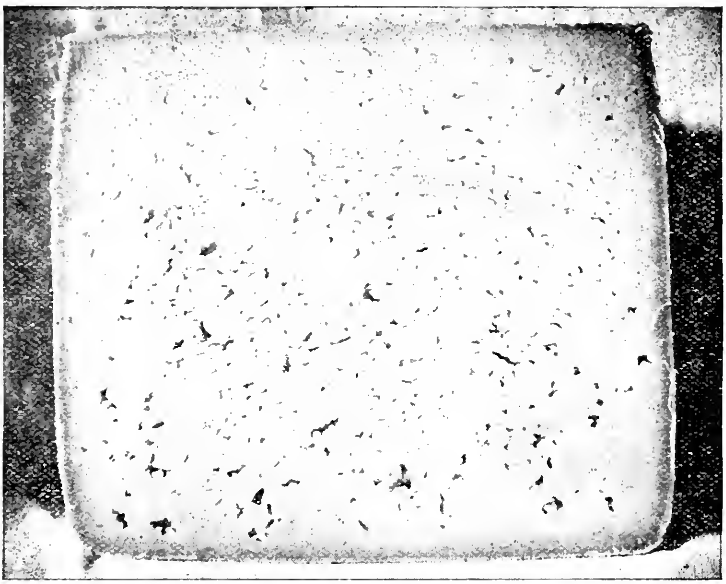


Fig. 2. [No bacterial starter.]

Upon investigating the nature of the gas produced, a rubber tube filled with water connected the fermentation tube with a Hempel's gas burette. The amount of gas after standing for some time measured 99.1 c. cm. The burette was then connected by means of a capillary tube with a Hempel's pipette containing potassium hydroxide. The gas was run into the pipette and the carbonic acid gas absorbed by shaking. When the remaining gas was returned to the burette, the volume of gas left measured only 22.14 c. cm. This was then passed into a Hempel's pipette containing alkaline pyrogallic acid and thoroughly shaken. When returned to burette the measurement, 22.14 c. cm., was the same as before passing into the pipette. Evidently no oxygen existed in the gas. The gas was again passed into the pipette over palladium asbestos to absorb the hydrogen by converting it into water. 16.96 c. cm. of the gas was disposed of in this manner. There remained unaccounted for 5.18 c. cm. of gas, which is neither carbonic acid gas, oxygen nor hydrogen. Its nature has not been determined. Therefore, out of 99.1 c. cm. of gas produced by this micro-organism, 76.96 c. cm. was carbonic acid gas, 16.96 c. cm. hydrogen and 5.18 c. cm. unaccounted for. In another determination where 52 3-5 c. cm. of gas was used, there proved to be 26 3-5 c. cm. of carbonic acid gas and 20 3-5 c. cm. of hydrogen, leaving 4 4-5 c. cm. undetermined.

In the first determination the culture had stood much longer than in the second,—in the first case six weeks, in the second about three weeks. The difference in time alters the relation of carbonic acid gas and hydrogen. This was borne out by further tests which showed the variability in the relation of carbonic acid gas to hydrogen. A study in the formation of gas by the action of this bacillus upon other substances may lend interest to the investigation. The Smith fermentation-tube was used in this instance and the relation of carbonic acid gas and hydrogen to each other was determined. It was at the same time compared with a stock-colon bacillus which had been in the laboratory for some time. For this determination yeast water was preferably used to ordinary bouillon because of the greater accuracy, and to this was added two per cent of each of the substances employed. These will be represented in the following table:

	Bacillus of gassy curd.	Bacillus coli communis.
Maltose	$H / Co_2 = \frac{2}{1}$	$H / Co_2 = \frac{4}{3}$
Lactose	$H / Co_2 = \frac{3}{2}$	$H / Co_2 = \frac{3}{2}$
Cane sugar	$H / Co_2 = \frac{3}{5}$	$H / Co_2 = \frac{4}{1}$
Levulose	$H / Co_2 = \frac{1}{1}$	$H / Co_2 = \frac{2}{1}$
Glucose	$H / Co_2 = \frac{4}{5}$	$H / Co_2 = \frac{4}{1}$

NOTE.—Owing to the impurities so frequently present in sugars and other carbohydrates, the author does not regard the above table as valuable in any other respect than indicating the possible range of this bacillus' activity.

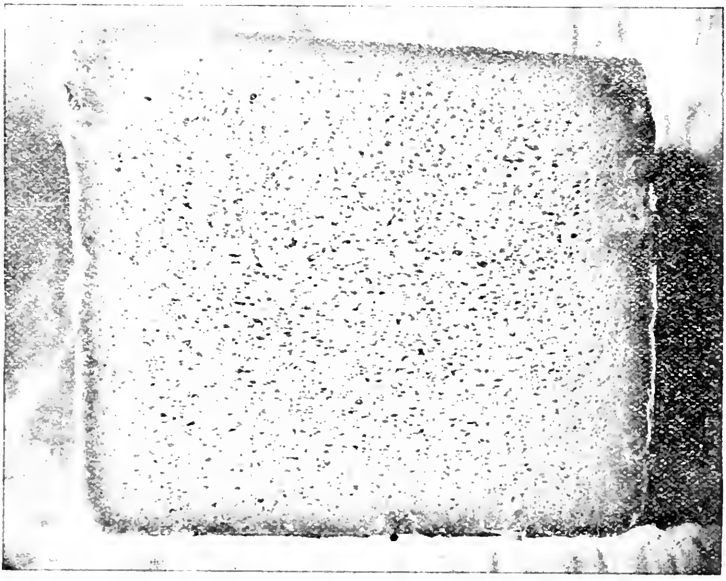


Fig. 3. [Gassy curd starter.]

Yeast water (as checks) yielded no gas—the action is therefore entirely on above substances. These tubes were treated to the same conditions for twenty-four hours at incubator temperature, 37½ degrees C. (98 degrees F.).

In a comparison of glucose and lactose of two per cent strength in each case, the glucose produced twice as much gas as the lactose in the same length of time. This micro-organism ferments glucose more readily, as is usually the case.

What evidences have been brought out in the investigations of the gas produced do in no wise tell us the relation of these gases in the cheese itself and the facts given may only by analogy be carried over. Under the conditions found in cheese, anaërobiosis, nitrogenous matter in abundance, and sugar in scarcity, the relation of the gases may be entirely changed about and partake of another nature. This is an

investigation which ought to be carried farther, but owing to a lack of facilities here it will have to stop where it is. There is no cheese-making, except during the short course, when it is almost impossible to control experiments.

Through the efficient aid of Mr. G. H. True and Mr. E. L. Aderhold, the effect of this micro-organism upon cheese-making and upon the cheese itself was made possible. A good supply of starter was made of this bacillus in question. Two lots of milk were taken, to one lot was added no starter and to the other lot was added a starter of the bacillus. The proper stage of acidity was marked at about the same time, but the curd from the milk without the starter was practically free from inflation, while the curd from the milk which received the starter was thoroughly inflated.

The difference in the cheese made from these different curds may be seen by consulting Fig. 2 and Fig. 3, representing cheese from the milk without the starter mentioned above, and the milk with a starter of this bacillus.

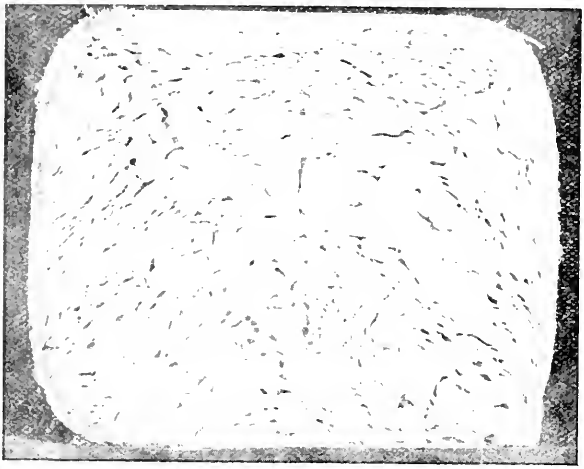


Fig. 4. [Without lactic acid starter as control.]

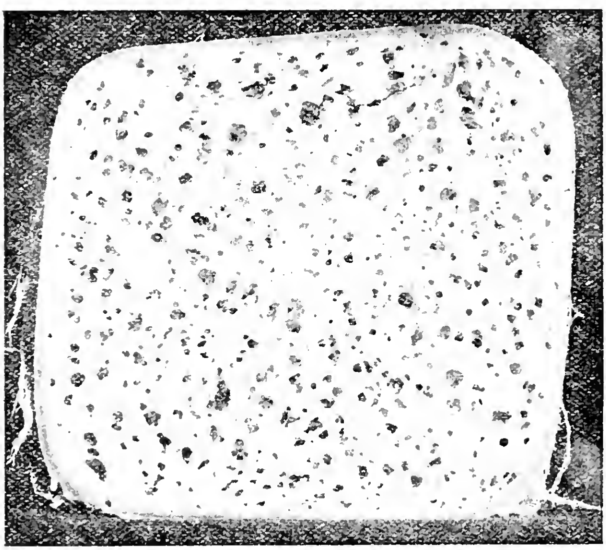


Fig. 5. [Without lactic acid as control.]

When these two specimens were cut open two weeks later the first, made without a starter, was very pleasant and agreeable to the taste, while the latter was of the tainted class and insipid.

Another series of experiments was carried out mainly to demonstrate the possible control of such curd. As will be seen by Fig. 4 and Fig. 5, the milk had been subjected to the influence of the gassy starter as in the above illustration.

Figs. 6 and 7 demonstrate a possible control by the use of a lactic acid starter before the starter of the "gassy" bacillus has done too much mischief. This is of real practical utility in demonstrating the value of a suitable starter to control or check the effect of obnoxious bacteria.

Although "gassy" cheese is one of the greatest obstacles to successful cheese-making in Michigan, yet it has been overcome in this specific instance by an intelligent use of starters. Two phases of this subject are open to the cheese-maker; he must either *avoid* the trouble by securing pure milk, or he must *overcome* it in one way or another.

Fig. 6. [With lactic acid starter as control.]

Fig. 7. [With lactic acid starter as control.]

The most feasible method is as has been stated—the starter. Of course, the cheese-maker is acquainted with the methods by which this difficulty may be detected in his patrons' milk, consequently it will not be necessary for me to enter into a discussion of these methods at this time.

THE BACILLUS ISOLATED FROM GASSY CURD.

Form and grouping.—This bacillus was not studied until it had been isolated by a series of platings to insure complete separation. It is a short bacillus, resembling very closely, under changes in nutrient material, micrococci. Short threads are frequently found; sometimes they appear very much like long bacilli, inasmuch as the lines of division are scarcely perceptible. However, when cultivated under some conditions which were not determinable, the thread-grouping was entirely lost. The thickness of the bacillus is practically constant and uniform. No distorted forms are recognized unless involutions may be found in the granular stage of the protoplasm, which is easily detected very early in the development of the cell. This gives rise to bi-polar bodies at times and at other times to spore-effects and the appearance of two or three globular refractive bodies in a single cell.

Measurement.—Length 2 to 5 micro-millimeters, thickness .5 micro-millimeters.

Motion.—No motion could be detected usually, but at times a slight movement was apparent.

Spores.—Occasionally spore-like bodies were noticeable, but they did not yield to spore reactions.

Flagella.—We did not succeed in establishing the presence of flagella.

Staining.—The bacillus responds very rapidly to the common aniline stains. It decolorizes quickly in contrast methods, consequently does not take Gram's staining method.

Colony. The colony begins as a dark, granular spot, with a well-defined border. It is round and rises above the surface of the gelatin slightly, developing very rapidly compared with the lactic acid germs found in the milk. As growth progresses, concentric bands are given off, surrounding the original colony, varying in density from the center toward the circumference. The color also shades from the dark center to the last concentric band at the circumference, which is very light. This may be seen in Fig. 8.

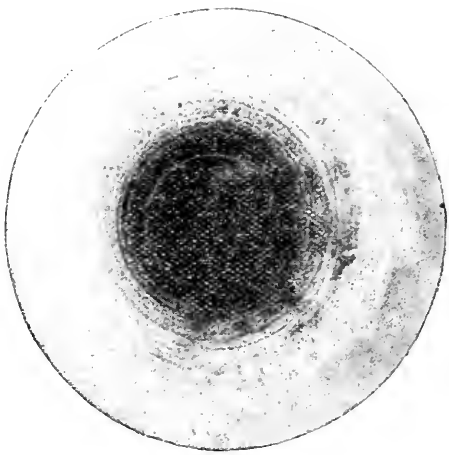


Fig. 8.

The outer border, after the colony has enlarged and spread over the gelatin for some distance, becomes serrated. Grown on some kinds of media, the colony is uniformly brown and granular, with an abrupt border, which may, at times, become fibrillated. The colony is always raised and rests upon the surface of the gelatin. Other types have been met with in the continued study of this micro-organism, but are considered to be rare and to be due to conditions which are not always under our control.

Gelatin tube-culture.—A white granular growth appears along the whole line of puncture with an irregular edge, apparently due to the fact that the colonies appearing near the border of the puncture are not thick enough to coalesce and have no tendency to run together. At the surface of the gelatin, the colony spreads much as a colony in the gelatin plate and corresponds almost identically with the colony illustrated in Fig. 8, with this exception,—it is denser and larger and bears the same relation as a giant colony to a simple colony. Fig. 9 will illustrate the growth along the puncture at the end of twenty-four hours. Gas bubbles will be noticed deep in the gelatin.

Bouillon tube-culture.—In bouillon the growth is heavy and soon settles to the bottom in a white, curdy mass, leaving the supernatent bouillon clear. In a few days a white, smooth, dense scum forms over the surface and projects about four millimeters up the side of the tube.

Inclined agar tube-culture.—A heavy, pearly-white raised growth appears along the line of inoculation. It has little tendency to spread over the surface and its border is escalloped.

Esmarch vegetable cultures—Potato.—A thick, creamy, grayish-white growth covers the surface of the potato. As it grows older, it becomes slightly darker. The odor is that of sour potatoes. It has no tendency to spread. On some potatoes the growth is very limited and on others very luxuriant. This is doubtless due to the varying reaction of the potatoes.

Oyster plant.—This seems to be an especially favorable medium for the growth of this germ. A heavy coating forms of a grayish-white color and extends over the entire surface. Throughout the growth, numerous pin-holes are visible with a crater-like ridge around them, which appear as if gas had escaped from the lower stratum.

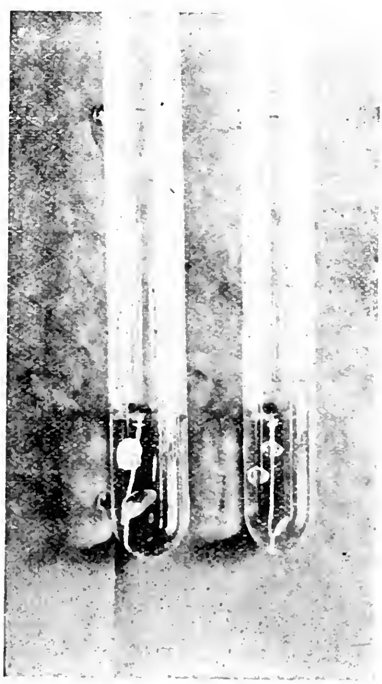


Fig. 9.

Parsnip.—A very thin, moist film is perceptible on the surface. The parsnip retains its natural color and the odor is that of the parsnip.

Rutabaga.—On this vegetable the growth is white and moist, but it is limited to

a thin film spreading out over the surface. There is no change in the color of this vegetable, but the odor is sour.

Sugar beet.—No visible growth appears on the surface, but the liquid in the bottom of the dish is dense with germ life. The odor and color are normal.

Onion.—A slight, whitish growth appears upon the surface of the slices, but the color of the onion is not changed.

Carrot.—A dry, white, wrinkled scum forms on the surface, the wrinkles radiating from the center. The growth is heavy and has a tendency to extend over the entire surface of the carrot, while the odor is of a sour vegetable.

Turnip.—Growth is abundant in a white, mealy-like film. Color of the turnip is unchanged and the sour odor less pronounced than in other vegetables.

Red beet.—There is a very slight film spreading over the surface. Beets do not smell unlike pickled beets.

Milk culture.—At first there is no perceptible change in the milk other than the gas visible in coming to the surface. As the culture grows older, there is an evident acid formation, sufficient to produce a partial coagulation of the casein. In litmus milk, the change of the litmus to red indicates the formation of acid. Upon standing for ninety days, the acidity diminishes to the neutral point, and the litmus again becomes blue, showing an alkaline reaction. The temperature under which the milk culture was studied was that of the room.

Indol reaction.—In Dunham's solution it gives positive reaction in forty-eight hours.

Growth.—Very rapid between 30 and 38 degrees C. In milk, it easily outstrips the lactic acid germs under ordinary conditions.

Temperature.—Grows readily from 20° to 30° C. From 30° to 38° growth is rapid. Minimum temperature is about 15° C., optimum temperature about 37° C., and the maximum temperature about 41° C., that is, it practically ceases to grow at this temperature. Killed at 60° C. for ten minutes.

Oxygen requirements.—The influence of oxygen is not decisive. It grows as readily in hydrogen as in the ordinary air conditions; in fact, the growth in hydrogen at times was more abundant than the growth in air. The gas production does not seem to be interfered with in any way under hydrogen conditions.

Acid production.—Lactic acid is usually produced in small quantities at first, gradually increasing in milk cultures until cultures are very old. Although qualitative tests point to the formation of acetic acid when grown upon vegetables, yet it cannot be stated definitely that such is the case.

Alkaline compounds.—The peculiar change in the reaction of milk after the duration of ninety days seems to point to a nitrogenous decomposition which is scarcely sufficiently marked to yield to chemical analysis. Yet this has its significance in the ripening of cheese where the nitrogenous environment and anærobic conditions would naturally further nitrogenous fermentation. It is a fact that cheese made with this germ as a starter always lacks in acidity, is insipid to the taste and tinges on the putrid class, none of which characteristics may be attributed to the presence of hydrogen formed by this germ in milk under ordinary conditions. The odor is that of putrid taint in cheese. For the above reasons, I am inclined to think that this micro-organism is capable of acting upon nitrogenous bodies, as in cheese, and producing products which are not found in its action upon milk under ordinary circumstances.

Gas production.—When grown in milk, hydrogen and carbonic acid gas are evolved in proportions of one to five. This, however, is variable, as will be noted in the preceding discussion.

Odor.—In the common nutrient media there is no perceptible odor. In milk no odor appears until the cultures become so old that it is hardly safe to determine odors. As has been stated, in cheese made with this micro-organism as a starter, there is a putrid taint, but of course it would be unsafe to draw the conclusion that it is due to the action of this micro-organism alone.

Pigment production.—Ordinarily, there is no evidence of pigment, but when grown on vegetables, in some instances, as the cultures become old, the growth becomes of a dirty brown color.

Behavior to gelatin.—Liquefaction of the gelatin has been determined in no instance.

Pathogenesis.—When injected into guinea pigs, either subcutaneously or intra-peritoneally, death resulted in a short period. One cubic centimeter introduced intra-peritoneally produced death in a 500 grams guinea pig in twenty-four hours. The abdominal organs were covered with a purulent layer consisting of pus cells and bac-

teria; the intestines were hyperæmic filled with flatus and brown watery feces. There was a large amount of serous exudate and this was of a brownish color. The germs were found in blood and organs. When a bouillon culture was injected underneath the skin in the amount of one cubic centimeter, death was delayed, but the germs gave rise to lesions which were fairly constant. A slight purulent condition was found beneath the skin adjacent to the point of inoculation. Usually the abdominal organs became involved, following the same course as when the germ was introduced intra-peritoneally. If one-tenth cubic centimeter was injected, the time of death was extended and the post-mortem appearances were better marked if anything.

This germ was not inoculated into other animals.

RESEMBLANCE TO THE COLON GROUP.

This germ doubtless belongs to the ærogenic group of bacteria. This view is based upon its morphology and cultural properties as well as its pathogenic tendencies. It is, so far as we know, a non-motile bacillus, differing in this respect from the colon group, but unfortunately, the motility of a germ is not the easiest to determine. At times I have believed the germ to be motile, but it was never sufficiently marked and constant to make a positive statement. I am in hopes that by passing it through a series of animals I shall be able to establish the question of motility and flagella production, but this must be a matter of the future. In its growth on gelatin and agar, potato, milk, there is practical identity. In the production of gas, there is close resemblance. Its relation to the thermal death-point, resistance, indol reaction, is practically that of the colon and so far as pathogenesis is concerned, I have been able to notice very little difference. For these reasons, while it is a distinct ærogenic micro-organism, I am led to believe that it is one of the colon group. It also corresponds very closely to the Moore and Ward germ.

CHARLES E. MARSHALL.

June 20, 1900.

[1]Russell, H. L.—Bulletin 62, Univ. of Wis., Agric. Experiment Station.
[2]Bolley & Hall.—Cheese-curd inflation, Cent. f. Bakt. Ab. II, Bd. I. S. 788.
[3]Moore & Ward.—Bulletin 158—Cornell Univ. Agric. Exper. Station.
[4]Jensen.—Cent. f. Bakt. Ab. II, Bd. IV, S. 265.
[5]Freudenreich.—Landwirtschaftliches, Jahrbuch. Bd. IV, S. 17.
[6]Weigmann.—"Milch Zeitung" Bd. XIX, S. 741.
[7]Bolley & Hall.—Loc. cit.
[8]Ward.—Bulletin 178, Cornell Univ. Exper. Station.

TUBERCULOSIS AND ITS MANAGEMENT.

BY C. E. MARSHALL.

Bulletin 184.—Bacteriological Department.

In dealing with a subject of this nature, the author is cognizant of the obstacles which obstruct the way to a satisfactory and definite understanding of the present attitude toward bovine tuberculosis. The scientific facts established in the study of this dreaded white plague are exceedingly numerous and the literature has become so widely disseminated and so voluminous that a further discussion seems hardly necessary. However, owing to the accumulation of scientific data and to the abundance of literature, this subject becomes more intricate and a fair presentation more difficult.

This station, in its work with tuberculosis, has endeavored to pick out those important factors of the disease, to verify them, and to present them in such a manner as to yield direct and beneficial results to stock-growers. Scarcely any effort has been made to follow out original lines of research because of many difficulties in the way which must be surmounted before any success could result in this direction.

What has given the ill-taste in the matter of tuberculosis (we know such to exist with many) comes from that class of hyper-enthusiasts and reading-scientists who take the experimental bread from the mouth of the experimenter and chew it and digest it according to their own individual methods of handling pabulum. It is essential to base our conclusions upon facts derived from experiments or those derived from practice, if we would reach healthful ideas concerning this topic. Opinion and prejudice, unless well founded upon the foregoing, should play no part in the formation of judgment. Unfortunately, there is perhaps no subject that is so unfairly treated, so mutilated, so distorted without substantial proof, as is tuberculosis.

No experimenter claims that an ultimate and safe judgment may be formed in dealing with this disease at the present time. There is still much to determine and learn, especially in the management of this disease, which can come only through years of actual experience. This is borne out by the enactment of many laws which have been proved inefficient in checking this disease. If once the importance of this disease can be impressed upon every stock-grower and the facts of the disease furnished him, education will be worth far more than drastic legislation.

WHAT IS TUBERCULOSIS?

Put aside all general notions of this disease such as may be formed from an acquaintance with scrofula, tabes, hydrocephalus and other forms, and confine the attention for the present to conditions found in a tuberculous body. This disease is recognized by tubercles or nodules sometimes pearly white, sometimes of a whitish yellow and sometimes of a reddish color. All sizes of tubercles appear, from those which require the aid of a microscope to discern, to those several inches in diameter. At first they are hard and fibrous but eventually become more pliable to the touch and may become gritty or calcareous from deposits of lime salts. Cut the small tubercle open and it appears to be of the same consistency throughout, cut a large tubercle open and the interior may be broken down into a yellowish white, creamy mass, and cut an old tubercle open and it is likely to resemble hardened and dried pus of long standing, yellow and very gravel-like to the edge of a knife. These three stages, the young firm fibrous nodule, the creamy pus deposit in the center with an outer fibrous coating, and the calcareous deposit, with its firm outer coating—represent only landmarks with all degrees of development and disintegration between. The pus may become of a cheesy consistency, then we get the caseated tubercle, or of a calcareous consistency, then we have the calcareous tubercle. Such are the nodules or tubercles which constitute

the disease of tuberculosis, whether in the throat, lungs, abdominal cavity or any other part of the body. Elsewhere we shall have something to say about the dissemination of these tubercles in the body.

What has just been said about tubercles is limited to the naked eye appearance. To see into them still farther requires the aid of the microscope. The tubercle in its youngest stage resembles a congested point in the tissues. There is an extraordinary increase in the number of cells. With the constant increase, due apparently to some irritant, the inner cells begin to disintegrate and the accretion is on the outer side. This process continues until considerable tissue is involved, and the tubercles take on their macroscopical appearances, which have been described above.

A tubercle seems to be the result of some irritant at work in the tissues. What that irritant was, years ago, proved to be a very difficult problem. Today we ascribe the irritation to one thing only—*the tubercle bacillus*. By no means, should it be understood that the contagiousness of tuberculosis is a matter of recent origin; it dates back into the past centuries when in many instances laws were enacted to isolate consumptive individuals and to burn everything with which such persons had come in contact. In fact, long before the tubercle bacillus had been discovered by Koch in 1882, its powers of producing tuberculosis were practically demonstrated by the inoculation of tuberculous virus from a sick animal into a sound animal.

What this tubercle bacillus is, can best be comprehended by referring to it as far beyond the vision of the naked eye. It is a single cell instead of a multiplicity of cells such as are found in the higher plants—a single cell, elongated so that it would resemble a section of a lead pencil, rod-shaped, with rounded corners and very slender. Its average length is about one-thirteen thousandth of an inch. The naked eye will resolve about two hundred lines to an inch, but put end to end, thirteen thousand tubercle bacilli would be required to make an inch. Usually when found in sputum or in tubercles these little rods or bacilli are slightly bent, giving them a characteristic appearance. In the state of nature, they are translucent or resemble ground glass if viewed in a drop of water. Occasionally they are found in little bunches, the individuals in which are arranged parallel to each other. At times there appear within each cell small bodies which have been regarded as spores by some. Single spores have also been attributed to these bacilli, but, while the spores remain questionably demonstrated, the general verdict seems to accept spore formation as absolute. It is difficult, for instance, to demonstrate tubercle bacilli in circulation and also in old broken down tubercles by the use of a microscope, yet, especially in the latter, transmission into a susceptible animal is easily made. Other forms of the tubercle bacillus appear. The branched form has been noted by several observers, but this may be considered rather unusual. For this reason it has been likened to the ray-fungus of lumpy jaw (actinomycosis). It is easily understood, if the size of this micro-organism is considered, how the disease may be easily disseminated and conveyed from one person to another.

In this connection arises the question whether the tubercle bacillus of man and cow is identical. Smith has shown some cultural, morphological and pathological differences existing between tubercle bacilli coming from a human source, as sputum, and those obtained from a bovine source. Although these differences exist, tubercle bacilli taken from human sputum are capable of producing tuberculosis in cattle, yet the progress of the disease is much slower than when the tubercle bacilli are secured from a bovine source. It is possible these differences are founded upon the environments of the bacillus in each case, and, as Smith states, they may be found in the diminished susceptibility of man or a higher pathogenic power of the bovine variety. The study of the tubercle bacillus in man and animal comparatively may lead to far-reaching results and may lead also to an elucidation of many features of tuberculosis which are little or unsatisfactorily understood at the present time.

It does not seem necessary at this time to demonstrate how it is proved that the tubercle bacillus is the sole cause of tuberculosis; yet the question is frequently put to us, "How do you know that the bacillus is the cause?" If we should see a field of wheat filled with daisies and the wheat itself was very light, we would at once suspect that the cause of the wheat failure was due to the daisies. This would be sufficient to satisfy many minds. But there are other possible causes for the failure of the wheat, such as soil, moisture, climate, etc., any one of which might be the cause. If every poor wheat field we saw had numerous daisies, we would be more convinced than ever that the daisies were the cause; yet soil, moisture, climate, etc., may be the cause so far as any evidence indicates. However, if we should take a piece of this same land, subject to the conditions of moisture and climate as above, and which we know

is free from daisies, and if we should sow this to wheat and secure a good crop, we would be better satisfied than ever that the failure of the wheat was due to the daisies. Should this last experiment be repeated hundreds of times with success, there would be no doubt any longer in our minds that the daisies bore a definite injurious relation to the production of wheat. Any farmer will accept this as sufficient proof in the above work; now that the daisies be substituted by tubercle bacilli and the proof extended, many farmers (I say many because I know this from actual experience) doubt it. Koch, in his initial work, examined hundreds of cases of tuberculosis and found tubercle bacilli in every case—this certainly corresponds to daisies in every poor wheat field. Not satisfied with this, he isolated this plant, the tubercle bacillus, just as you might take a daisy and isolate it in a pot by itself and freed from all other plants. Instead of using soil for growing it, he, Koch, used blood serum in which there were no other plants, germs, growing. Having secured the plant, tubercle bacillus, in pure culture, as you would the daisy in the pot, known to be unmolested by any other plant, he introduces this single plant, tubercle bacillus, into the body of a sound animal, such as a guinea pig, just as it is possible to introduce the daisy into a wheat field which is free from this plant. The tubercle bacilli develop in the body of the guinea pig quite rapidly and eventually kill the guinea pig; the daisy develops quite rapidly in the wheat field and gradually kills the wheat. It is just as easy to follow one as the other. The proof goes still farther, the tubercle bacilli only are found in the body of the animal, and no other germs, and these bacilli can again be used for inoculating another animal. Koch, besides finding the bacilli in hundreds of cases of tuberculosis, inoculated hundreds of animals, mostly guinea pigs.

Many individuals who depend upon their experience in reading articles on tuberculosis, and who find comfort in nourishing their own logical deductions, without having ever seen a tubercle bacillus or a piece of tuberculous tissue, make guinea-pig inoculation a scapegoat. The farmer who has battered against experience all his life and has become a successful farmer, smiles (to himself) when he sees his city friend, who has scarcely seen a farm, buy one and endeavor to manage it. Before going on the farm the city friend was very conversant about farm topics, but when the reality arose it was quite different and a failure resulted. Such is the case with many everyday newspaper writers on the subject of tuberculosis. Their reading knowledge is very good, but their experimental knowledge is very faulty. One of these prominent writers goes so far as to say that experimenters draw most of their deductions or inductions, as the case may be, from the inoculation of guinea pigs, and carry them over in their application to man and animals. It may be said with truth, I think, that no one knows better than the bacteriologist the exact relation existing between this animal and man so far as experimentation goes, and it is also true that the bacteriologist is more careful of his conclusions than the individual who would frame them for him. Fortunately there are not many such writers, but they do much injury if allowed freedom of action.

When a guinea pig contracts tuberculosis from a certain source, such as milk and flesh, the experimenter or bacteriologist does not say that the same material will produce tuberculosis in man or animal. He would not dare make such a statement, for so far as he is concerned he is not certain. He says such material is likely to produce or may produce tuberculosis in man. Why this qualification?

1. Man cannot be made an experimental animal.
2. The exact susceptibility of man to tuberculosis is unknown.
3. The great susceptibility of the guinea pig to tuberculosis by inoculation is known.
4. The contagiousness and infectiousness of tuberculosis in man are known.
5. The factors which render some men more susceptible, apparently, than others, are *practically* unknown.
6. The bacillus (tubercle) in man and guinea pig is identical.

(Some of these points will be considered later.—Author.)

All of these thoughts pass through the mind of the bacteriologist and necessarily make him conservative in his conclusions. It is usually the man who speaks for the scientific man, who originates the sweeping statements. It has been established that the tubercle bacillus can be carried over from man to guinea pig, but with what facility it could be carried back from guinea pig to man is not settled. Consequently it is impossible to carry results back and forth with a precision that is shown in carrying results from animal to animal of the same species. It is a recognized truth of bacteriology that a pathogenic germ may be carried through certain animals and become inocuous to animals which were susceptible in a high degree, and on the other hand it may be made intensely virulent to animals which were wholly immune to the

germ in its weakened condition by simply passing it through a series of animals—from the most susceptible to the least susceptible. This action of disease-producing bacteria should always be borne in mind to correctly formulate opinions; it is nevertheless too frequently overlooked. The guinea pig is susceptible to the weak form of the tubercle bacillus, which in its weak form may not be capable of producing tuberculosis in a strong man. What conclusions should be reached? Man cannot be used to determine the exact knowledge to make our logical chain complete. We know that a strong man is susceptible to tuberculosis at times and we know that some men seem to be predisposed to tuberculosis. I say we know, because these are statements generally accepted by careful observers. The next statement may require demonstration. Tubercle bacilli coming from one source may be much more virulent than those coming from another source, whether in man or animal. To demonstrate this the author took material selected from two patients, one a case of very long standing, and the other a rapidly progressing case. While it was impossible to secure equal amounts, so far as the number of bacilli was concerned, to make it approach equality, an estimate of the number of germs determined was used as a basis to proportion the amounts. With these determined proportions guinea pigs were inoculated. The animals inoculated with material from the case of long standing survived several weeks longer than the animals inoculated from the other case. Experiments repeated with tuberculous material taken from cattle gave similar results. These conclusions accord with the general accepted view. What conclusion shall be reached? I repeat, in the face of such facts. If fifty glasses of water were placed before a thirsty man and one contained poison, to the man's knowledge, there is no doubt that he would consider his thirsty condition before he drank, if he drank at all. So it is in experiments with guinea pigs; they tell us that there is danger, but do not tell us how great that danger is. The bacteriologist can therefore indicate danger by his simple inoculation of a guinea pig, but cannot indicate the amount of danger by that simple inoculation.

That the disease of tuberculosis is contagious has long been accepted by scientists, but there are those who still doubt the truth of this statement, even among physicians. It is not my purpose to justify the attitude of scientists, but rather to repeat some of the evidence used in establishing this statement. What has been said relative to guinea pigs as conclusive experimental animals will appear constantly in the proof which is about to be given, and instead of being confined to guinea pigs it is applicable to various other animals.

The classic experiments of Gerlach, the director of the Berlin Veterinary School, come down to us as the first crucial tests made upon the infectiousness of tuberculous material. Inasmuch as these experiments were made in 1869, thirteen years before Koch discovered the tubercle bacillus, there may be cause for chagrin on our part to acknowledge that the conditions which control tuberculosis have not become better known thirty years later. Gerlach took some tuberculous nodules from a tuberculous cow and placed them underneath the skin of a goat one year old. Three weeks after inoculation, tubercles as large as walnuts appeared at the point of inoculation. Six months after inoculation the disease had reached the pleural cavity and attacked the bronchial glands and the lungs. Again, a healthy and well nourished calf, eight days old, was fed with milk from a cow the last fifty days of her life. Fifty days from the time of the last feeding, or one hundred days from the commencement, the calf was killed. Tuberculosis had developed to a high degree. The pleura, bronchial glands, lungs, and mesenteric glands showed tubercles of good size, many of them as large as walnuts. In an eight months' lamb, fed with milk from the same cow, incipient tuberculosis had developed when killed three months after. A pig, six to eight weeks old, was fed for twelve days with milk from the same cow as above, and was killed thirty days after. The lungs, bronchial glands and mesenteric glands were badly affected with tuberculosis. These experiments of Gerlach (1874), following upon those of Villemin's (1865), demonstrated conclusively, even in the light of our present knowledge, that tuberculosis in a cow could be conveyed to other animals by inoculation and by feeding. Villemin's work also showed that tuberculosis of the human subject could be conveyed to lower animals by inoculation of tuberculous sputum. His methods were similar to those of Gerlach. Tappeiner succeeded in inducing the disease in rabbits, guinea pigs and dogs by causing them to inhale powdered and suspended tuberculous sputum. The laboratory servant while conducting these experiments also fell a victim to this disease. Cornet has found tubercle bacilli in dust. Sputum becoming dry, soon is pulverized and escapes into the air. Out of 392 samples of dust gathered from asylums, prisons, hospitals where consumptives are found, Cornet determined 59 to contain tubercle bacilli.

That human tuberculosis may be transmitted to the bovine species, we have the work of Bollinger, Baumgarten, Sidney Martin, Smith, Frothingham and Dinwiddie to testify. Each has demonstrated that the tubercle bacillus found in man is capable of setting up tuberculosis in cattle, both by inoculation and by feeding. It is a difficult matter to decide whether the tubercle bacilli coming from the human subject are less virulent upon the bovine subject than tubercle bacilli coming from the bovine species; yet the inoculations of human tuberculous material act in most cases somewhat tardily upon cattle. On the other hand, tubercle bacilli taken from the bovine source is exceedingly variable in its virulence, if we may draw such a conclusion from two experiments carried on here at the college. These experiments have two purposes, first to show the transmissibility of bovine tuberculosis to pigs, which has been repeatedly shown by other workers, as Gerlach, Ernst, Dinwiddie, Thomassen and others, and to show the difference in the virulence of material employed. Six pigs, three weeks old, and all from the same litter, were divided into two lots, three in each lot. To one lot was fed in milk for four days, tuberculous material taken from a cow which had run down very rapidly before she was tested with tuberculin and killed. The lungs of this animal were highly affected with tuberculosis. These were chopped fine and the tissue fluids extracted by means of a meat press. About one pint of this fluid was added to one hundred pounds of milk. One c. c. of this milk introduced into the abdominal cavity of guinea pigs caused their death from tuberculosis in eight weeks. The one lot of three pigs received this greatly diluted tuberculous material for four days. After the first day, however, the milk was sour, notwithstanding it was kept constantly in a refrigerator at 15° C. As soon as this milk was consumed the feeding was the same as the controlling lot of three pigs which were fed on heated milk and meal. At the end of six months all of these pigs were killed. The controlling three were free from disease as would be expected. They had had no tuberculous material and their food was carefully watched against infection, as was also the food of the three which received the tuberculously infected milk. When the pigs which had eaten the infected milk were opened, although the outward appearances were such as to indicate the animals in the best of health and flesh, the glands and organs contained numerous tubercles. There is no need of entering into a detailed description of the post-mortem appearances; suffice it to say that the mesenteric, portal, mediastinal and pharyngeal glands were thoroughly tuberculous. The liver, lungs and spleen were more or less invaded with tubercles. In this instance every animal fed with tuberculously infected milk became infected with the disease, while each check animal was entirely free from any trace of it. From the great dilution and from the action of the material upon the pigs, as well as guinea pigs, also from the rapid decadence of the cow, it may be justifiable to conclude that the tubercle bacilli were of a high degree of virulence. Our next experiment might be considered a jump to the other extreme. In this experiment were eight pigs and four calves. The pigs were obtained from the same litter and were placed in four separate pens with two in each pen. The calves were arranged with only one in each pen. The pigs were labeled pens one, two, three and four, and the calves, one, two, three and four. The tuberculous material was obtained from cattle which had previously reacted several times to tuberculin, but from ante-mortem and post-mortem appearances were holding their own, and so far as is known and as suspected at the time might have been recovering. [These animals will be considered later.—Author.] The material was chopped fine, as in the preceding experiment, and the tissue fluids extracted by means of a meat press. The material was more abundant than in the preceding test and much larger quantities of the fluid extracted were used with smaller amounts of milk. A pint of this material was mixed with twelve quarts of pasteurized milk. The pigs in pen one received four feedings (all they could drink) of this infected milk; pigs in pen three received only one feeding of this milk; pigs in pens two and four acted as controls or checks. After the feeding of the pens one and three with infected milk, all the pigs received pasteurized milk and meal only. Calf one received four feedings of this same tuberculously infected milk and calf two one feeding only. Calves three and four acted as controls or checks. Calves one and two, after the feeding of the infected milk, received the same as the checks or controls, pasteurized milk, with meal and hay. Six months from the beginning of the above experiment all the above animals were killed and nothing of a tuberculous nature could be positively demonstrated in any of the animals. It can now be added that guinea pigs inoculated with this material were slow in succumbing to tuberculosis and half of the number did not contract the disease at all. This experiment seems to indicate that it is possible for tuberculosis to reach a latent condition in which the tubercle bacilli are practically

inert. A word of caution at this point may be advantageous. This does not mean that tuberculosis is less dangerous or contagious than supposed; it merely points out the possibility of an inert condition of the tubercle bacilli. a condition which has always been regarded as possible. Further experiments along this line, we hope, will bring us to a better understanding of this experiment. That the transmission of tuberculosis from man to cattle and cattle to other animals has been sufficiently demonstrated, there can be no manner of doubt. The corollary of this presents quite another question. There is no indisputable proof or evidence. As an example of what evidence there is to offer, I might be permitted to quote,—"The four-year-old grandson of Col. Henry B. Beecher, of N. Broadway, died of tubercular meningitis. His physician says that the disease undoubtedly originated in two fine Alderney cows, which Col. Beecher bought last May. The child was perfectly healthy prior to the attack, and his parents on both sides have no tubercular tendency. The cows, being suspected, were tested with tuberculin, and reacted in the usual way." While such evidence as this has great weight, it cannot be offered as direct proof; yet it tends to establish the truth of the problem that tuberculous contagion may be carried directly from animal to man. The number of such cases is unlimited and if one will take the trouble to search literature, especially of a medical nature, he may convince himself. This evidence in connection with the identity of the tubercle bacillus and pathological lesions in both animal and man is worthy of the gravest consideration in the absence of absolute proof.

THE PREVALENCE OF TUBERCULOSIS.

In 1890 Dr. Arthur Ransome estimated the number of deaths annually from tuberculosis in the British Isles to be 70,000. Prof. Leyden in 1894 computed the number of deaths in Germany to be 170,000 yearly. Dr. Charles Denison of Denver attributes 40 per cent of deaths between the ages of twenty and forty years in New York City to tuberculosis. In the State of Michigan, between the years 1884 and 1893, there was an average annual report of 2,140 deaths from consumption and 166 deaths from tubercular diseases. This is believed to be not more than two-thirds of the deaths due to this disease because of a failure to report. In the first six months of 1898 there were 1,329 deaths reported from tuberculosis in the State. Tuberculosis, according to statistics, produces more than twice as many deaths in our State as any other single contagious disease. The following statement is made by Dr. George F. Keen of Rhode Island: "This is a disease which has claimed more victims than all the wars and all the plagues and scourges of the human race. Even during the few short years since Koch's discovery, over two million persons on this continent have succumbed to its fatal infection. In the last two decades, in Cincinnati, out of a total mortality of 119,089, there have been 17,353 deaths from this dread disease. The annual tribute of the United States to this scourge is over 100,000 of its inhabitants. Each year the world yields up 1,095,000; each day, 300; each minute, two of its people as a sacrifice to this plague. Of the 70,000,000 individuals now peopling these United States, 10,000,000 must inevitably die of this disease if the present ratio is kept up."

In regard to the prevalence of this disease among animals, the following figures will give some definite idea. In 1896, in the abattoir at Leipzig, Germany, 32 9-10 per cent of the animals killed were found to be tuberculous. In Zwickau, 37 1-2 per cent were tuberculous. At Hamburg, in 1895, 8 56-100 per cent were tuberculous. The statistics from the abattoir at Vienna, from 1893 to 1895, show a percentage of 1 79-100, 1 60-100, 1 30-100 per cent tuberculous. On the other hand, in Austria, by the use of the tuberculin test, the percentage runs as high as 39 84-100 and 43 per cent. In Switzerland, in the canton at Fribourg, of the animals dying or slaughtered, 12 14-100 per cent show tuberculosis. By the use of tuberculin the percentage in some cases runs as high as 52½ per cent. In the abattoir at Toulouse, France, 9 28-100 per cent of the animals killed were found to be tuberculous. The tuberculin test in some parts reaches 25 per cent. Of 19,004 cattle tested in Belgium in 1896, 48 8-10 per cent reacted. The abattoir at Amsterdam, Holland, in 1896, showed a percentage of 8 12-100 tuberculous; in Rotterdam, 4 per cent. Of the animals slaughtered at Liverpool, there was found 10 6-10 per cent tuberculous out of 4,321 milk cows. In the abattoir at Manchester, 29 4-10 per cent were tuberculous. In Denmark, by the use of tuberculin, 28 8-10 per cent have been found to be tuberculous in the year 1898. Of the animals slaughtered in the abattoir at Copenhagen in 1897, there were 26 87-100 per cent tuberculous. Of 35,992 animals tested in Sweden by Svensson, 42 2-10 per cent were found to be tuberculous. In Norway, of 30,787 animals tested, 8 4-10 per cent were found to be tuberculous. In Massachusetts, in 1894, of 3,295 tested, 24 58-100 per cent reacted. In Pennsylvania, in 1896, of 10,000 tested, about 20 per cent reacted.

In Connecticut, of 6,304 tested, 14 2-10 per cent reacted. Of 2,417 tested in 1895 in New York state, 405 reacted. Of 849 cattle tested in Michigan by Dr. Grange, 107 reacted, or 13 per cent. Dr. Dunphy, now State Veterinarian, reports that about 13 per cent of the animals tested by him in Michigan are tuberculous.

The statistics relating to the number of animals tested and reacting in the State of Michigan do not represent the true extent of the disease, for it is a fact that most of the herds tested by the State Live Stock Sanitary Commission have belonged to State institutions, or growers of blooded stock, and have consisted of highly-bred stock, which seem to be either more susceptible to tuberculosis or have been the avenue by which the disease has entered the State through importation. The College, in the summer of 1897, purchased thirty grade dairy cows in different sections of the State, not too far distant from Lansing. These cows were brought to the College and tested with tuberculin. Not one reacted. Only one developed tuberculosis the year following and in this case the disease was in its incipient form. The author has made a test of several grade animals since in the vicinity of the College, but has not found tuberculosis in a single case. Although aware that our evidence is too limited to form a wholesome judgment of the amount of tuberculosis prevailing among cattle in the State of Michigan, my contention is, do we not have less than would be indicated by the report of the State Sanitary Commission, since in all likelihood the native herds possess a freedom from this disease, not belonging to pure-bred stock unless introduced into the herd through the introduction of strange animals?

DISSEMINATION OF TUBERCULOSIS.

Various methods by which this disease is transmitted from one to another in the human family may furnish us with sufficient data to understand the various avenues of dissemination in the bovine species. Perhaps the most common path of contagion is through the sputum, which leaves a tuberculous subject, finds its way to the pavement, floor or ground, becomes dessicated, pulverized, enters the dust of the air and eventually lodges in the respiratory tract of some individual prepared to contract the disease. Again, it may become lodged in the handkerchief, dried and by this method furnish another channel by which it enters the respiratory organs. It has also been determined that the fine, invisible salivary spray that passes from the mouth contaminated with tubercle bacilli may contain the germs of this disease. Experimentally, the possibility of such infection has been shown through the administration of atomized tuberculous liquids to animals.

In our study of the discharges from the nose and mouth of the tuberculous animals we have had under our charge, we have been able to demonstrate the presence of tubercle bacilli in two or three cases. In one case in particular, the tubercle bacillus was exceptionally numerous. That this is one of the most common means of conveying the disease from one animal to another can scarcely be doubted, as Dr. Ruhling of Göttingen pointed out in 1774, by the following statement: "The malady is transmitted to sound animals by direct contact of animals standing side by side and licking each other and breathing the expired air direct from the diseased lungs; the frequenting of the same pastures will also serve to propagate it." It is a very common occurrence to find upon testing with tuberculin that animals adjacent to a tuberculous animal are more likely to be tuberculous than any others in the herd. The author's attention has been called to a very interesting case in which a test had been made and tuberculosis found very prevalent. An effort was made to build up a new herd out of the offspring of the old by isolation. It was supposed that every avenue of infection was shut off, but the young animals continued to contract the disease and the cause of this infection was not explained until it was found that the owner, in establishing his isolation, had neglected to look into the water supply, which flowed from the drinking trough of the old herd to the young stock. When this was attended to, no more developments appeared. The sputum evidently from the old herd or nostril discharges entered the drinking water and was carried to the young herd. I have picked up discharges, coming from tuberculous cows, on straw in the stalls, which, upon examination, showed the presence of tubercle bacilli. Therefore the discharges from the mouth and nostrils of tuberculous animals are fraught with exceeding danger, and, through the various avenues, reach sound animals and produce in the susceptible of them this fearful disease.

The feces is a carrier of tubercle bacilli at times. It is possible for the sputum coming from the lungs to be swallowed, conveyed through the intestines and issued from the body in the fecal matter. As evidence of this, a case here at the College may be adduced: A cow which had tuberculosis of the lungs and the pleural lining,

and no tuberculous lesions elsewhere in the body, so far as could be detected by a careful post-mortem examination, had for a year previous to her death given off tubercle bacilli constantly in her feces. This fact was established by injecting fecal matter into guinea pigs at periods of about a month apart. Some of the guinea pigs so treated died from septic diseases, but those which withstood the injection for a few days developed tuberculosis in three, four and five weeks. The source of the tubercle bacilli in this animal must have been the lungs, which were badly diseased, inasmuch as no distinguishable tubercles were found anywhere in the abdominal cavity. On the other hand, feces from the other animals, about twenty in number, never showed the presence of tubercle bacilli by inoculative tests, although these inoculations were made at different intervals of time, not exceeding two months, in order to establish the presence of any contagion. (See Mysie 44.)

Tuberculosis of the urinary organs is not very common and yet such cases are occasionally met with. Whenever they exist, the urine generally contains the bacilli in greater or less numbers. In our experience with the tuberculous College herd, we have never been able to find tuberculosis in these organs. The urine from these cattle was tested from time to time by inoculation, but in no instance did any of the tests reveal tubercle bacilli. However, in the management of tuberculosis, this means of eliminating the disease-virus should not be disregarded.

No avenue of dissemination has been so hotly discussed as that which the udder offers. It may be that the discussion hinges on the possible presence of tubercle bacilli in the secretions of the udder, and whether, if present, these tubercle bacilli are capable of setting up tuberculosis in either man or animal. As regards the latter problem, we refer to the preceding pages, in which it has been taken up with the purpose of showing the absolute impossibility of demonstrating it beyond question. Should anyone who is so desirous of drawing general conclusions from a very slight omission in the logical deductions be willing to submit himself to the ordeal of inoculation, in one form or another, then we could regard him as sincere in his convictions and not prejudiced lest it may injure him in a commercial sense. From all the cases which have been collected and which show an intimate connection between tuberculous milk and tuberculosis of the human being, I leave it with him who is free from cant and prejudice to draw his own conclusions from the facts presented. The simple question is, can the tubercle bacillus from the bovine species infect man?

Referring to the former problem mentioned above, I desire to enter into a review of what has been done, not so much because I deem it essential to this bulletin, but because, if the mind has a tendency to be diverted in a direction most pleasing to itself, that agent which would divert it into other directions must be a faithful watch and must constantly keep before that mind the convincing proof which would divert it. This is my excuse for reviewing what has been reviewed and re-reviewed whenever tuberculosis has been associated with milk or milk supplies.

Perroncito observed in 1892 that milk and butter contained the true bacilli of tuberculosis. Milk from some tuberculous cows fed by Gerlach to rabbits, pigs and calves, conveyed the disease to the animals, while milk from other tuberculous cows failed to do it. Hirschberger succeeded in producing tuberculosis by inoculation of rabbits fourteen times with the milk of twenty-nine tuberculous cows of apparently sound udder. From sixty-three cows selected for their apparently sound udders, Bang produced tuberculosis from the milk of nine of them. The work of Doctors Smith and Kilbourne established tuberculous milk in three cows out of six with apparently sound udders. Of two cows with tuberculous udders, one gave tuberculous milk and the other did not. Ernst added much to our knowledge of this subject by his extensive experiments. His investigations may be summed up in his own language as follows:

I. Examinations were made, by means of the microscope, of the milk from tuberculous animals with no disease of the udder, according to veterinary examination.

"There were one hundred twenty-one examinations of cream and milk, the specimens coming from thirty-six different animals. The bacilli of tuberculosis were found in one or more cover-glasses upon nineteen different occasions."

"These nineteen positive results were obtained from twelve different animals and the bacilli were found in about equal proportion in the milk and cream,—they were seen more than once in milk from the same cow, at different examinations, six times."

"The bacilli were actually seen, therefore, in specimens from one-third, 33 per cent, of the animals examined."

"That these animals were actually affected with tuberculosis, and that the udder was free from disease, was proved in all possible cases by careful post-mortem examinations. These were conducted upon twenty out of thirty-six animals."

II. Guinea pigs were inoculated with cream and milk.

"Eighty-eight guinea pigs were inoculated with milk from fifteen different cows. Tuberculosis was found in twelve and these results came after the use of milk or cream from six different animals."

III. Inoculation of rabbits.

"Ninety-five rabbits were used for the same purposes and under the same conditions as were the guinea pigs. Of these rabbits, five were for various reasons useless for purposes of investigation, leaving ninety which were subjected to full examination. For these ninety animals milk from nineteen different cows was used one or more times and tuberculosis was found in six animals inoculated with milk from four different cows."

IV. Rabbits fed with milk.

"There were used forty-eight animals with positive (tuberculosis) results in two, and both of these animals were fed upon milk from a single cow."

V. Pigs fed with milk.

"Twelve healthy animals were used with positive results (demonstration of the bacilli under the microscope) in five. In two others, nodules presenting the gross appearance of tuberculosis were found, but the material was not saved for microscopic examination. In any case, nearly fifty per cent of the animals were shown to be tuberculous."

VI.—Calves fed with milk.

"Of these twenty-one animals, eight, or over 33 per cent, were shown to be tuberculous."

All of these cows were free from tuberculosis of the udder.

Bay made five hundred sixty-three tests for tubercle bacilli in milk, three hundred fifty-nine unmixed and two hundred four mixed milk. In the three hundred fifty-nine tests he found fifty-one containing tubercle bacilli and in the two hundred four mixed milk tests he found four containing tubercle bacilli. Of nine tests made by Buege with the market milk of Halle, two gave evidence of tuberculosis. Two animals were used in each test. Both animals died which were inoculated with one sample and only one of the two inoculated with another sample. Dr. Sydney Martin examined the milk from ten tuberculous cows with apparently sound udders and did not find the bacilli in any of the milk. With the milk from five tuberculous cows with tuberculous udders inoculated into twenty-one guinea pigs, tuberculosis resulted in each instance. No diminution was noted in the virulence for a dose of even 5-100 to 1-10 c. c. diluted with wholesome milk. Dr. Hope of Liverpool states that the investigations of the bacteriologists showed that 2 8-10 per cent of the samples of milk taken from the city shippers contained the tubercle bacillus.

Professor Allan MacFadyean makes the following report on one hundred samples of milk taken from the Hackney District, England:

"Jenner Institute of Preventive Medicine, August 3, 1899.

SIR—I beg to submit the following report upon the samples of milk forwarded by you to the Jenner Institute for examination as to the presence of tubercle bacilli:

The samples of milk (one hundred in number) were received at intervals from March 9 to May 30, 1899. The fresh samples were examined immediately on their arrival. The milk was centrifugalised for thirty minutes, the cream was then stirred from the top, and the whole centrifugalised for a further period of thirty minutes. In this way the bacteria present in the milk were sedimented. The sedimented portions of the milk were used for examination. A series of microscopical specimens was made from each sample, but such a direct examination does not yield satisfactory results. The only reliable test is by means of inoculation experiments and these were carried out with each sample of the milk. The accompanying table gives the results obtained, both positive and negative.

A period of four to six weeks must elapse before the diagnosis can experimentally be established and the investigation has consequently extended over some months.

The result may be briefly summarized:

1. Seventeen samples of milk were found to contain tubercle bacilli of virulent character.

2. Twenty-three animals succumbed prematurely. It was consequently impossible to establish a diagnosis in these instances.

3. Seventy-seven samples were therefore fully and fairly tested. Taking the 77

absolute tests that were carried out and the seventeen positive results that were obtained, the proportion of milks from the Hackney District containing tubercle bacilli was found to be 22 per cent.

I am, yours faithfully,

ALLAN MACFADYEAN, M. D., Director."

The writer has subjected fifty specimens of milk secured from different parts of the State of Michigan to inoculation tests for tubercle bacilli. Sixteen of these samples came from cows which reacted to tuberculin. In only one case did the milk set up tuberculosis in the guinea pigs and this milk came from one of the sixteen known tuberculous animals. Periodical tests were made of the milk from the tuberculous cows at the College, resulting in only one sample of tuberculous milk. This sample came from a cow two or three days before she died of tuberculosis, but which at previous tests for tubercle bacilli in her milk had given negative results. Upon the examination of her udder after death, there were signs of incipient tuberculosis. This work would indicate that in all probability the presence of tubercle bacilli in milk is not a common occurrence in the State of Michigan, but, although rare, it by no means bespeaks indifference to the dissemination of this disease through the milk supply. As long as this experiment station had milking cows which had responded to tuberculin in its possession, occasional tests were made of the milk from these cows. Thirteen cows have entered into these tests, but none of them have ever given signs of possessing tuberculous udders, with the exception of the one named above. All but four have been slaughtered up to the time of writing and careful post-mortem examinations were unable to detect anything of a tuberculous nature in the udder.

An experiment was undertaken at this laboratory to study the distribution of tubercle bacilli in milk and its products. Inasmuch as there was no milk containing tubercle bacilli from a naturally infected source, it became necessary to render the milk tuberculous by artificial means. To accomplish this, lung tissue was secured from a tuberculous cow which had run down very rapidly with the disease and had been killed. The lungs were a solid mass of hard tubercles, with here and there a tubercle containing creamy pus. About six pounds of this tissue was chopped very fine, then transferred to a meat press. In the meat press some water was added to it to moisten it and then pressure was applied. Together with the water, there was obtained about one pound of juice from this mass. This extracted juice was added to 120 pounds of morning's milk and thoroughly mixed. The microscopic examination of the expressed juice revealed numerous tubercle bacilli and upon an examination of the milk after the addition of the expressed juice, a marked diminution was noticeable. The milk was then passed through, after being mixed with the expressed juice, a Mikado Separator. A microscopic examination was made of the slime, skimmed milk, cream, butter made from the cream, and the buttermilk. An attempt was made to estimate the relative number of tubercle bacilli in these different products. To do this, a small platinum loop was used, and as nearly as could be estimated, definite quantities were taken from each of the products. Twelve cover-slips were made from each product and each cover-slip was allowed fifteen minutes' time in counting tubercle bacilli found in the specimen. The figures in the following table represent the number of tubercle bacilli counted in each specimen during the alloted time. While this table may not represent the exact proportion existing, it doubtless approximates the truth:

	First specimen.	Second specimen.	Third specimen.	Fourth specimen.	Fifth specimen.	Sixth specimen.	Seventh specimen.	Eighth specimen.	Ninth specimen.	Tenth specimen.	Eleventh specimen.	Twelfth specimen.	Total.
Expressed tissue juice	282	369	327	240	195	390	132	138	177	300	522	288	3360
Milk after juice was added	5	12	15	16	0	0	14	11	0	4	4	2	83
Slime after passing separator	6	57	6	0	27	27	12	102	24	12	27	69	369
Skimmed milk after passing separator	5	0	0	6	2	0	2	4	2	1	3	13	38
Cream after passing separator	0	4	1	0	1	4	1	0	6	4	2	0	23
Butter made from cream	0	0	0	0	2	1	2	0	6	4	2	4	21
Buttermilk from butter	0	2	5	0	3	2	3	5	6	0	0	3	29

Moore used for infecting milk, to ascertain the action of the separator upon the tubercle bacillus, a pure culture, which he ground in a mortar containing sand, and then filtered this material with a few cubic centimeters of sterilized bouillon through a layer of cotton, which removed the sand and large clumps of bacilli. The filtrate was added to milk and the milk put through a separator making 7,200 revolutions per minute. His dilution was so great that only thirty per cent of the preparations made from the infected milk showed the presence of the germs. By microscopic examination he did not find the bacilli in the skimmed milk, cream, or in the milk left in the bowl of the separator, but found them in the slime from the side of the bowl in a considerable number. He afterward demonstrated the presence of the bacilli in the skimmed milk and cream by animal experiment. From his work, the demonstration of tubercle bacilli is positive in the several milk products, but the ratio existing is wanting, owing to the high dilution he worked with.

As regards the disposal of the products made from the milk in the above experiment of this laboratory, the cream was ripened and made into butter the following day after separation, the buttermilk and the skimmed milk were fed to pigs, with proper controls. All of the products including the expressed juice and the milk before separation, were tested by means of guinea pigs, to establish their infectious nature. All the inoculations into guinea pigs resulted in the production of tuberculosis of a virulent type. The guinea pigs died in three or four weeks. The pigs fed with the skimmed milk and buttermilk developed pronounced general tuberculosis in six months, while the control pigs were free from the disease. The feed used for these pigs after the consumption of the skimmed milk and buttermilk consisted of pasteurized milk, middlings and bran. The butter made from the cream was put away in a refrigerator and amounts about the size of a pea introduced subcutaneously in guinea pigs from time to time. Its virulence remained unabated from August 12 to April 25. The last inoculation seemed to be as strongly virulent as the first. The inoculations after April 25 produced death in guinea pigs in a day or two because of the presence of some other pathogenic germ which could not be overcome by various devised methods, consequently a record of the tubercle bacilli present was lost from April 25. However, this is sufficient to demonstrate the tenaciousness of the tubercle bacillus in butter.

From the above citations and our work here at the laboratory, there is little room left to establish a substantial doubt that the milk of tuberculous cows may contain the virus of the disease and that this virus may also find its way into milk products. So firmly do the Danes believe that this is one way of transmitting the disease that they have put into effect a law which requires that milk must undergo a pasteurization of 85 degrees momentarily in order to rid it of the tubercle bacilli which may be present. By this means, no cream is made into butter, nor skimmed milk sent home to the farm, without ridding it of the possible presence of tubercle bacilli. Through such an effort, they hope to keep the young stock free from this disease.

Meat is another avenue of dissemination. Although no experiments have been carried on here at this laboratory to verify experiments already completed, it seems pertinent to quote results already obtained on the possibility of tuberculous infection through meat. Thomassen, in reviewing the work of M. van der Sluis, inspector of the abattoir at Amsterdam, draws the following conclusions from his work: "Of ten pigs fed upon tuberculous meat, three, or 30 per cent, became infected. Of five animals serving as controls, none revealed tuberculous lesions. A resumé of the ten animals is as follows:

A	killed	104	days after first,	54	days after last feeding, having consumed	3¼	ko. meat.	
B	succumbed	54	days after first,	42	days after last feeding, having consumed	3¼	ko. meat.	
D	killed	135	days after first,	90	days after last feeding, having consumed	3.9	ko. meat.	
E	"	139	" " "	94	" " " " " "	3.9	" "	
G	"	118	" " "	102	" " " " " "	4.17	" "	
H	"	118	" " "	102	" " " " " "	4.17	" "	
K	"	140	" " "	91	" " " " " "	11.5	" "	Tuberculous.
L	"	140	" " "	91	" " " " " "	11.5	" "	
N	"	131	" " "	75	" " " " " "	15	" "	Tuberculous.
O	"	188	" " "	132	" " " " " "	15	" "	Tuberculous."

Thomassen adds further that these experiments prove the flesh of tuberculous animals to be capable of provoking tuberculosis through ingestion, but on the other hand, if the disease is localized, the danger is reduced to the minimum. This conclusion is founded upon the fact that in the feeding of these pigs, material was used from animals having general tuberculosis.

The Local Government Board of Great Britain reports several experiments by Cruikshank and MacFadyean. Cruikshank showed a high degree of infection, but MacFadyean's results were negative. In the former case, the muscles were trimmed

roughly by the butcher; in the latter case, the muscles were taken in parts remote from the tuberculous lesions under aseptic precautions.

I embody some of the report, as quoted by Secretary Bryce of the Provincial Board of Health for Ontario: "In 1891, experiments with cooked meat were made. On May 21, 1891, twenty-one healthy guinea pigs were divided into four lots and fed with meat from diaphragm, spleen and lungs. It was minced, made into sausages and submitted to different degrees of cooking, boiling and frying. In Pen A, meat was thoroughly cooked; in B, underdone; in C, well boiled; in D, lightly boiled; in E, fed raw. Feeding was repeated for three days. First experiments begun May 21, had failed on July 10: second experiments begun July 17, were repeated for three days. The arrangement and feeding of animals are as follows:

"A, four guinea pigs fed (17th and 18th July) on raw tuberculous meat as above.

"B, four guinea pigs fed (18th July) on meat as fed to A, but boiled for fifteen minutes.

"C, four guinea pigs fed on meat as above, but boiled for forty minutes.

"D. Three guinea pigs originally fed on partially boiled meat on 21st April.

"These three were inoculated on the 18th of July with pieces of the tuberculous material from a tuberculous cow. Two died from blood poisoning within fifty-six hours. The third one remained apparently healthy up to the 18th of September, when it was killed and examined. Post-mortem examination showed well nourished body, but extensive local tubercles at seat of inoculation (inner thigh). Lungs, spleen and kidneys were also implicated.

"1st of August, 1891.—The one remaining guinea pig in D was transferred to X (square box), and in D were placed four healthy young guinea pigs from stock. The four were fed on ordinary food with milk from a tuberculous udder. This feeding was continued for several days.

"1st of August, 1891.—Animals in A, B and C were fed again as on 18th of July, namely:

"A, raw meat.

"B, boiled twenty minutes.

"C, boiled forty minutes.

"1st of August, 1891.—In E on this date are three guinea pigs as originally fed on raw, tuberculous meat on 21st of April and ordinary food ever since.

"All the animals were then put on ordinary food (hay, oats and plenty of green meat) until the 19th of September, when they were all sent to the Royal Veterinary College for examination.

Post-mortem results are seen in the following table:

		Lungs.	Bronchial glands.	Liver.	Spleen.	Kidneys.	Mesenteric glands.	Intestines.
A	1	T	T	T	T	T	T	.....
	2	.....	.....	.....	.....	.....	T	.....
	3	T	.....	T	T	.....	T	.....
	4	.....	.....	T	.....	.....	T	T
B	5	.....	.....	.....	.....	.....	.....	.....
	6	.....	.....	.....	.....	.....	.....	.....
	7	.....	.....	T	.....	.....	.....	.....
	8	T	.....	T	.....	T	T	T
C	9	.....	.....	.....	.....	.....	.....	.....
	10	.....	.....	T	.....	.....	.....	.....
	11	.....	.....	T	T	.....	.....	.....
	12	.....	.....	.....	.....	.....	.....	.....
E	13	T	T	T	T	.....	.....	.....
	14	.....	.....	T	T	.....	T	.....
	15	T	.....	.....	.....	.....	.....	.....
		5	2	10	5	2	6	3

NOTE.—T refers to organs tuberculous.

"It is, however, to be noticed that these animals were fed with two different lots of tuberculous meat, and it is impossible to decide which lot was most infective. But there is no doubt of the fact that cooking the meat in the manner described failed to destroy its infectivity."

"In another series of experiments, four lots of guinea pigs, four in each lot, were fed on tuberculous material which had been cooked by being placed in cold water, the meat having been cut into slices half an inch thick and two inches square. The vessel containing the meat was put over a small furnace, and the water was gradually brought to the boiling point. The meat was kept boiling for fifteen minutes in one case and thirty minutes in the next instance. Two lots of guinea pigs were fed several times on the meat which had been kept boiling for fifteen minutes, and the other two lots with the meat which had been cooked thirty minutes. All of them were killed after several weeks and found to be free from all traces of tubercle. It appears, therefore, that thorough cooking is effectual in destroying the activity of tubercle virus. But it is also evident that such thorough cooking as was effected in this case could not be applied to large joints, nor to any kind of meat without destroying its flavor."

Other experiments have contributed much to this interesting topic. Two hundred rabbits and two hundred guinea pigs were inoculated by Perroncito with the muscles of tuberculous cattle in various stages. None of the animals developed tuberculosis. Nocard has fed dogs, pigs, calves, guinea pigs and kittens with the muscles of tuberculous cows. No infection followed. A calf six weeks old was fed by Galtier with eight pounds of raw muscles from a condemned tuberculous cow without producing tuberculosis. Galtier has also injected fifteen guinea pigs and sheep with muscles of tuberculous cows and has been able to induce tuberculosis. Kastner, using muscle juice from twelve cows slightly tuberculous, inoculated sixteen rabbits in the peritoneal cavity with no results.

During November, 1899, tests were made of tuberculous meat in the form of glands which were chopped fine, macerated with milk, and fed. There were five pens of pigs about six weeks old. Each pen held two pigs. Pens 1, 3 and 5 received the tuberculous milk, Pens 2 and 4 acted as controls. To Pen 1 was given milk containing tuberculous material supposed to be of a very virulent nature, Pen 3 received milk containing tuberculous material of medium virulence, Pen 5 received milk of a very low form of virulence. Guinea pigs were inoculated from each sample of milk and they all contracted tuberculosis. Six months after feeding all the pigs which remained alive were killed. One pig of Pen 1 had generalized tuberculosis, the lungs were solid. In the other pig of Pen 1 no trace of tuberculosis could be found. Both pigs of Pen 2, which were controls, were free from the disease. One pig of Pen 3 died at the end of five months of general tuberculosis, the lungs being solid. The other pig had the bronchial and right pharyngeal glands affected. Both pigs of Pen 4, which were controls, were sound. Both pigs of Pen 5 were sound. Fifty per cent of the pigs fed with tuberculous material contracted tuberculosis. There seemed to be no difference existing between what we supposed to be the very virulent and the less virulent tuberculous materials. It is usually, probably, a matter of conjecture. At the same time that these pigs were fed, materials which were used for Pens 3 and 5 were injected into two calves. Both contracted tuberculosis and it had advanced considerably in six months' time. Two check calves remained free from the disease.

From what has been given, infection is possible from tuberculous meat, and especially is this true if the disease becomes generalized. Even then there seems to be considerable doubt whether the virus is in the muscles tested or whether it is on the surface of the muscles, having gotten there through the careless use of instruments. Wherever careful experiments have been conducted, it seems to point to the contamination of the meat in one way or another during slaughtering. On the other hand, meat which is tuberculous when fed to animals, almost invariably sets up the disease. In the case of generalized tuberculosis, where glands in almost every region are infected, it would seem strange if the small lymphatic glands found in the muscle tissue were not also infected, inasmuch as this disease radiates through the lymphatic channels from the center of infection gradually to the other parts. Where only a single gland is involved in the animal, so slow and gradual is the progress, it is very doubtful whether the disease would reach the muscle tissues very quickly. Therefore, when we find a posterior pharyngeal gland or a posterior mediastinal gland affected, from the evidence that is offered, it seems a waste to destroy the carcass, since there is little chance of conveying the disease by this means.

The dissemination of tuberculosis through other avenues than the above mentioned is so uncommon that it need be only mentioned. It is possible to convey tuber-

culosis through wounds, through careless use of instruments, by sleeping in a room previously occupied by a tuberculous subject, through infected clothing, by sexual congress when the generative organs are involved.

THE PATH OF TUBERCULOSIS IN THE BODY.

When the germ has located itself in one part or the other of the body, there is a tubercle formed at that point and the virus probably does not leave this place until the tubercle begins to disintegrate. Then the virus apparently follows the lymphatic channels and the disease may be distributed to various parts of the body. If a guinea pig is inoculated subcutaneously in the side and the various stages of development are noted as the disease advances, it will be found that a tubercle has developed at the point of inoculation first and that the gland nearest to the point of inoculation next becomes affected. If the inoculation happens to be nearest the inguinal region, the inguinal glands are first affected; if nearest the axillary region, the axillary glands are first affected; if the inoculation is over the abdominal cavity, there is a gradual penetration of the disease and the infection is carried to the lymphatic glands and mesenteric glands of this cavity; if the inoculation is over the thoracic cavity, the virus may penetrate to this cavity and involve the bronchial, the mediastinal glands and the lungs. Sometimes, however, the axillary and inguinal glands on the opposite side of the body become affected before and simultaneous with the entrance of the disease to the thoracic and abdominal cavities.

If the virus is introduced into the abdominal cavity or into the thoracic cavity, the disease frequently advances so far as to kill the animal before it advances from the cavity into which it was introduced. Yet it is a common thing for the disease to pass from the abdominal cavity into the thoracic cavity or from the thoracic cavity into the abdominal cavity, when either the abdominal or thoracic cavity respectively receives the virus.

When the virus is taken through the mouth by means of food as in the case of feeding swine, the disease is first apparent in the mesenteric glands, from which it seems to spread to the liver and spleen, and finally makes its way toward the thoracic cavity. This is the usual path we have found by inoculation according to this method. However, this path is not always strictly adhered to. The pigs in consuming inoculated food sometimes inoculate themselves through the thoracic tract. At such times, the glands and lungs of the thorax first become involved and so rapidly develop the disease that the pig dies before there is much evidence of it in the mesenteric glands, where we would expect to find the first traces of the disease.

Of course when the virus is introduced through respiration, the disease usually makes all its progress in the lungs and neighboring glands. One of the first pair of glands to show the disease, and perhaps where the disease is as commonly found as anywhere, is the posterior pharyngeal glands. I have noticed the affection of these glands where tuberculous lesions were found elsewhere, only in the thoracic cavity and also only in the abdominal cavity. This would indicate that these glands are as prone to infection through the ingestion of food as through the ingestion of the virus by respiration. When the disease enters the thoracic cavity, the posterior mediastinal glands are among the first to show signs of tuberculosis, then follow the bronchial glands and the lymphatic glands throughout the lung tissue. Deviations from this path of infection are frequent.

The significance of the paths taken by the virus in its distribution throughout the body and the production of generalized tuberculosis appears to place the responsibility of conveying the tubercle bacilli from one part to another upon the lymphatic channels. This is borne out by the usual development of the disease in those organs contiguous to the one already affected. It may be that the blood vessels enter into this function of a virus carrier more prominently than we suspect, still there is little known that would support this view.

GEOGRAPHICAL DISTRIBUTION OF TUBERCULOSIS.

So generally distributed all over the world is this disease that to arrive at or even hypothetically draw definite conclusions would perhaps be bold. I desire more to offer a suggestion or two than to put anything into the form of a positive statement.

Authentic history does not tell us very explicitly where the home of this disease was originally, but there appears to be sufficient data to make central and southern Europe the place from which this trouble has radiated to various parts of the world. The Danes believe that they have brought tuberculosis into Denmark by means of

importation of cattle from countries south of them. Sweden follows closely upon Denmark in the amount of tuberculosis, and into Norway, where tuberculosis is less rife, there is less importation. England has been in close communication with the continent and has produced a good development of the disease. It is fair to suppose that all the newer countries, as America, Australia, New Zealand, have received their share through importation from the older countries. That one diseased animal is capable of conveying the disease to a herd of sound animals has been repeatedly demonstrated. Sections which have been practically free from imported stock are at the present time practically free from tuberculosis. Dr. Pearson of Pennsylvania gives an illustration where such a condition has existed. The common practice of placing pure bred stock which are directly descendent from imported stock, or have been recently imported, with the native herd, in order to build up the herd, is a pernicious practice in some ways; for one or two animals thus introduced may be the means of eventually destroying the value of the whole herd. I believe that stock growers and dairymen are beginning to realize that this is the greatest possible chance of ruining their herds through tuberculosis.

SUSCEPTIBILITY TO TUBERCULOSIS.

There is no phase of this subject which is so enshrouded in ignorance as individual susceptibility to this disease. Although the presence of the germs are essential for its development, yet there must be besides the germs a specific diathesis. The tubercle bacilli may be present in the body tissues and yet be unable to produce the disease, therefore there must be a concomitant relation existing between the tubercle bacilli and tissues where they find their lodgment before tuberculosis can be established. To account for the preparation of the tissues to receive the bacillus several factors are induced, no one of which may be said to be the most important.

Improper ventilation has been frequently associated with bovine tuberculosis. For this reason it is claimed that this agent plays a part in the production of the disease. It is readily understood, although inexplicable, that a failure in supplying the necessary amount of fresh air would lead eventually to a lessened vigor of the body tissues. In another way facts seem to establish a definite bearing of ventilation upon tuberculosis. Where the tuberculin test has yielded the greatest number of victims, there has been in the majority of cases a close, poorly ventilated and perhaps badly lighted stable, in which sufficient air for a free exchange would be impracticable. An effort to secure warmth, through kindness and economy, seems to have led to unsatisfactory results. Yet it is claimed that tuberculosis is little prevalent among the Esquimaux. If this statement is true, the huddled condition of this people in their small huts would hardly coincide with the foregoing views. Notwithstanding this, it would seem probable that if the habits of the Esquimaux were transferred to Michigan there would be little opportunity of anybody's indulging in them to escape the white plague. The American Indian appears to have been free from tuberculosis until the advent of the white man. With the corralling of the Indians upon reservations and with the introduction of many of the customs of the white man, tuberculosis has developed to such a degree that it is a veritable plague which threatens the eradication of the whole race. Living under original and natural conditions, largely in the free, open air, they were able to ward off or evade the disease which now so sadly afflicts them. Although in following up the evidence in this matter both sides offer substantial illustrations, still we cannot help concluding that improper ventilation does exert some influence in preparing the tissues for the reception of the germ.

There is nothing so baneful in the weakening of constitutional vigor as in-breeding. Of course we do not claim that this is in any way the direct cause of tuberculosis, yet we believe that it paves the way for infection. In-breeding in man is not permissible, but as we pass down in the grade of animals, it becomes less and less noticeable, until in the case of the lowest animals, in-breeding may be carried out with impunity. In the bovine species it is very doubtful whether in-breeding may be allowed with much greater advantage than in the human species. Great attention is given at the present time in breeding to type. If this is possible, does it not seem just as plausible to breed into the offspring exaggerated weaknesses through in-breeding processes? It is not necessary that this weakness be as visible as the udder on a cow, for it may be resident in the tissues and permeate the whole body. Supposing the father is robust and the mother possesses a weakness of the stomach (in human parents) the offspring is likely to inherit that weakness from the mother. Supposing now that this weakness be a family disorder and then the mother and the father came from one branch or other of the family, what would be the natural result? The weakness must be exaggerated.

So, although in-bred cattle may apparently possess strong and vigorous constitutions, nevertheless wherever weaknesses exist, they will become magnified, whether visible or invisible.

This tendency to in-breeding is becoming alarming in some directions because of the strong desire to create characteristics of a special type for dairy work or beef production. Ideals are before the mind constantly, and everything short of the appearance of the type and the development of the characteristics are utterly disregarded. It appears most rational that in breeding for specific purposes, a vigorous, sound, constitution is really more essential than some exaggerated feature, if the welfare of the race is to be maintained.

The feeding of animals no doubt plays a role of considerable importance. Too much food reduces vitality with the same precision as an insufficient amount. The functional activities of the body are limited, and, if they be crowded, the results will be noted in the excreta. In a normal body there is an equilibrium established between the constituents which enter the body and those which are excreted. Crowd the functional activities by forced feeding or by any undue stimulation and this equilibrium will become abnormal and destroyed. When this condition is reached, the vitality is reduced, then the tubercle bacilli may begin their operations. Should we go farther and analyze this derangement of functional activities we, perhaps, could resolve it into its physical, chemical and physiological bearing. For instance, we may consider the act of drinking a physical factor and that this water provides a solvent and a carrier for many of the constituents of the body as well as a menstruum for all chemical actions. In the chemical aspect it is pertinent to note the transformation of food into tissue and through the metabolism of the cells the excretion of waste products. The physiological aspect introduces us into the life of the cells themselves and gives us an inkling of what life is through its effects. In order to be normal these three elements must work harmoniously. The one must not gain the ascendency over the other and the other must not fail in its powers. Perfect adjustment must exist, for it is through this very adjustment that the equilibrium mentioned above may be maintained, consequently to unduly exercise the one and not the other is to throw the parts out of harmony and to inevitably produce devitalization.

It is a peculiar fact that the carniverous animals are practically free from tuberculosis. There may be something in the fact that a meat diet so alters the conditions of the body tissues that the tubercle bacilli may not be able to gain a foothold. Sir Andrew Clark has said: "When I was a young man I had to choose between gout and phthisis, and I chose gout." A meat diet increases the acidity of the body fluids, while a vegetable diet reduces this acidity. As McClintock puts it: "A vegetarian diet decreases the acidity of the urine, increases the alkalinity of the blood. The blood of herbivora is poorer in hemoglobin than that of the carnivora. Feed a dog on carbohydrates and his hemoglobin decreases. So, too, there is more oxygen contained in the blood of carnivora. The arterial blood of dogs contains in one hundred volumes, nineteen to twenty volumes of oxygen, whereas the arterial blood of sheep and rabbits contains from ten to fifteen volumes." This author does not claim that if we were all carnivora our ailments would cease, but that perhaps others would take the place of tuberculosis.

The above discussion may have some connection with a quite common belief that our best animals are the most likely to contract tuberculosis. It has been the experience in the College herd, and I understand that it is the experience of those who are capable of rendering a fair judgment, that the best milkers and the best beef animals possess a greater susceptibility to the disease. In the case of such animals, it is always the inclination to push them to their utmost, whether unconsciously or purposely. The result is, injudicious feeding and injudicious care are given to these animals. It is true that a cow may be forced to give a greater amount of milk for a short period by increasing the amount of proper kinds of food, and it is possible also to as carefully handle her as a babe in an incubator, yet neither the gorging of food nor the fondling of her as a babe contributes one whit of energy or vitality to her body, but on the other hand materially diminishes both.

The lighting and drainage of stables also have a marked influence in determining the health of animals. The obnoxious gases arising from poor drainage, or the deleterious gases coming as decomposition products from the accumulated organic matter on the floors of stables, must exert no little influence upon the health of the animals enclosed in such stables. Light has a beneficial effect in that it is a strong disinfectant and has the power to reduce the moisture contained in the stable room. It acts also, probably, upon the animal as upon the plant, an essential factor is the sustenance of life.

What exercise may do for an animal is difficult to indicate. The practice of keeping cows shut up constantly without any exercise is increasing and what it may lead to may only be predicted after carefully considering the importance of exercise to every animal body. Shut an animal up, one which is accustomed to roaming over considerable territory, and you immediately see signs of deterioration. Shut up a cow month after month without any exercise and it must result in the reduction of vigor. Cease to use a muscle, it becomes diminutive and weak. Cease to use any organ, and it will become weak. Cease to use the body, and the body will become weak. Treat an animal as a machine and it will need oiling very soon and wear out in a short time. Treat an animal as an object of life, subject to the natural laws of life, and it will be useful for a great many years. To abide by the laws of nature is to progress, to violate these laws is to retrogress.

No matter what the devitalizing agent may be, whether it is one of the factors mentioned above or something else, it probably exercises a potent influence upon the production of tuberculosis in the presence of the tubercle bacilli.

SYMPTOMS OF TUBERCULOSIS.

In the incipient stages of this disease, no subjective symptoms may be pointed out as indicating tuberculosis. It is only when the disease has advanced to a well developed stage that symptoms begin to manifest themselves, and even then the symptoms may be such as would not lead to a positive diagnosis. Consequently there is nothing to cause the farmer to suspect that tuberculosis is present in his herd until some animal begins to decline so rapidly as to point to possible tuberculosis.

How long it takes this disease to run its course from the time of infection to death is unknown, but it is believed that it may take the acute form and carry off an animal in a few months, or the chronic form, and make the period of duration that of many years, the animal finally dying from some other disease. Inasmuch as the author has had no experience in studying the clinical aspect of this disease as would be afforded by a practitioner, he desires to be allowed to quote in toto the succinct statement of symptoms by Prof. Law of Cornell University, as given in bulletin 170 of that experiment station:

"Tuberculosis of the lungs may be chronic or acute. The chronic cases may last indefinitely with no other symptom than an occasional cough on leaving the hot stable or cool air, when suddenly raised in the stall, when made to run, or when drinking cold water or eating dusty food. The cough is usually small, dry, wheezing, and repeated several times in succession. The general health may seem to be good, the subject may be fat or a heavy milker. To the trained ear, wheezing, crackling, or other unnatural sounds, may be heard in the lungs, or they may fail of detection. There may be a discharge from the nose, which, when stained and placed under the microscope, may show bacilli, but by cleansing the nose with the tongue the animal makes this test practically impossible.

"Acute tuberculosis of the lungs, on the other hand, may prove fatal in a month. It is attended with rapid loss of condition, staring coat, elevated temperature, hurried breathing, frequent weak, husky or rattling cough, heavy, maukish breath, and nasal discharge containing gritty particles or opaque yellowish masses. Pinching of the back, breast bone or spaces between the ribs, or striking the ribs with the knuckles may cause wincing, groaning or cough, and auscultation over the ribs may detect sounds of friction, wheezing, creaking, crepitation, rattling or blowing, etc. Percussion over the chest detects areas of lack of resonance corresponding to the seats of tubercles or pulmonary infiltration. A significant feature is that these areas of flatness are distributed over the lungs, and not confined to one spot, as is common in pneumonia. Appetite and rumination fail, bloating occurs after meals, the bowels may become irregular and indications of tuberculosis in the throat or superficial lip glands may appear.

"Tuberculosis of the stomach and bowels is common in young animals living on milk, but is not infrequent in the mature animal as well. It may come from infected milk, or from the swallowing of the diseased products coming from the throat or lungs. In calves there may be noted indigestion, fœtid diarrhea, bloating, and finally cough and expectoration or swelling of the superficial lymph glands. In older cattle there may be irregular appetite and rumination, bloating after meals, costiveness, alternating with diarrhea, colics, and marked emaciation. The oiled hand introduced into the rectum may detect the enlarged mesenteric glands, which must be carefully distinguished from hardened feces in the bowels, from the ovaries, from masses of fat, and from the cotyledons of the womb.

"Tuberculosis of the womb and ovaries may depend on infection by the bull, or may be a complication of intestinal and peritoneal tuberculosis. It is usually marked by sterility, abortion, by frequency and intensity of œstrum, and by marked emaciation. Sometimes there is a white vaginal discharge.

"Tuberculosis of the liver, spleen and pancreas is also a common accompaniment of infection of the bowel or abdominal cavity. The liver and spleen are especially liable to suffer from being on the line of circulation of the portal vein, which brings blood from all the other abdominal digestive organs. The lymph glands on the posterior aspect of the liver are especially liable to suffer. With liver tuberculosis there may be jaundice, accompanied by other symptoms of digestive trouble, but as in the affection of the spleen and pancreas, there is oftentimes only an indefinite ill health.

"Tuberculosis of the kidneys may be attended by extra tenderness of the loins to pinching and by frequent passage of urine, which may be discolored by blood or pus. The urine is likely to contain microscopic cylindroid casts and when stained these may show tubercle bacilli.

"Tuberculosis of the udder is usually manifested by a circumscribed or general swelling of one or more quarters, without at first special tenderness, and this generally extends to the whole gland. The milk may be watery, glumous, or even bloody, and the lymph glands in front of the udder and behind are enlarged and hardened. The tuberculous nature of the lesions can only be certainly determined by the discovery of the tubercle bacillus in the milk, by the successful inoculation of the milk into a small animal, or by the tuberculin test.

"Tuberculosis of the throat and pharyngeal lymph glands is one of the most common forms of tuberculosis in cattle. It causes a wheezing breathing, glairy discharge from the nose or mouth, difficulty in swallowing and a loose gurgling cough. The diseased glands may be felt as soft swellings around the throat, or as shrunken hard nodular bodies, or as masses fluctuating by reason of their liquid contents. When the disease extends to the interior of the larynx, it causes a persistent paroxysmal, husky cough.

"The lymph glands inside the lower jaw or those near the root of the ear may swell up, soften and discharge a cheesy or thick creamy fluid containing the bacillus.

"The lymph glands inside the chest—bronchial, mediastinal, etc.—are especially liable to suffer, as they receive the infected lymph which comes from the diseased lungs. These often suffer when no lung disease can be found, the bacilli having passed through the lung without forming any primary lesion in that organ, or those that have been formed having healed. These are often attended by no distinctive symptoms, and require the tuberculin test.

"Lymph glands in front of the middle of the shoulder blade may be suspected if of unequal size and form on the two sides, if hard and nodular, or if soft and fluctuating. They rarely caseate and burst.

"Other lymph glands that may be similarly affected, and that are superficial enough to be felt, are the glands at the entrance of the chest in front of the two first ribs, the glands on the flank above and in front of the stifle, and, in the young, the glands situated high up in the groin.

"Tuberculosis of the bones and joints is seen in young growing animals, affecting especially the large joints of the limbs, the elbow and knee, the stifle and hock, but also at times the bones and joints of the digits. The ends of the bones become enlarged and tender and the joints over-distended, tense and elastic. The lameness may be extreme."

IS TUBERCULOSIS INCURABLE?

This is a question which is frequently asked by the stock-grower. A word of explanation may be pertinent.

So far as is known there is no infallible cure for this disease. If we may judge from the lesions in post-mortem examinations, we may safely say that there is evidence of cure. This is as true of animals as of man. In fact, in cases where tuberculosis is still present, there are, in the form of cicatricial tissue, the marks of old tuberculous abscesses. In a cow killed this year, there were found a great number of active tubercles of large size, and in the liver three or four spots of fibrous tissue, one to two inches in diameter, marking the location of previously active tubercles. Such as these indicate that tubercles may run their course and disintegrate completely, leaving only a scar behind. In the spring of 1899, three animals were killed which had reacted in 1896. They had ceased to react to tuberculin. The post-mortem examination resulted in the finding of single glands affected, all of which were in a calcareous condition. Here also we have evidence of a check in the progress of the

disease. On the other hand, there were some cows which had been under the same treatment as the three mentioned, and these when killed showed evident progress of the disease or, at least, the disease in a most active condition. Thus on the one hand there seems to be improvement and on the other a decline. As long as it is not possible to detect the one from the other before post-mortem, this places the stock-grower in a no better plight.

There may be encouragement in the work of de Schweinitz of Washington, who has been successful in producing a serum which in an experimental way has been able to check and even cure tuberculosis. It should be remembered that this is only in its experimental stage, and is not yet available nor practicable for application. It is mentioned to illustrate the trend of thought and the lines along which work is being done.

In the treatment of humans, the sanitoria of Germany have accomplished wonderful results. The treatment in these consists of life in the open air, plenty and substantial food, pure water and suitable exercise, all of which are under the stringent regulations of the physicians in charge. This is, therefore, simply the intelligent application of hygienic principles.

BREEDS OF CATTLE AFFECTED.

At the present time, there is not much said regarding the susceptibility of different breeds to tuberculosis. So far as is known, all breeds are equally susceptible. In the College herd the Shorthorn, the Jersey, the Holstein, the Guernsey, Polled Angus, Red Polled, have alike responded to the tuberculin test. The kind of breed apparently has little influence.

HISTORY OF TUBERCULOSIS IN THE COLLEGE HERD.

It has been stated with good reasons that the College herd had suffered severely from tuberculosis previous to 1889, but there is nothing authentic which would give us any adequate notion of the extent of the disease. In 1889 Prof. Davenport made some notes in the herd record-book in regard to the existence of tuberculosis at that time. It is my purpose to present these notes practically in toto.

"Having become known in the autumn of 1899 that the herd was to some extent affected with tuberculosis and that some cases had been known before, it was decided that vigorous measures should be taken.

"A resolution of the Board of Agriculture, passed January 6, 1890, condemned to slaughter every animal suspected of the disease and all related closely to those found affected. It was also deemed advisable to reduce the herd by slaughtering all culls and cross-bred animals at as early a day as practicable to learn, if possible, the limits of this disease. In this plan the Farm Committee of the Board concurred.

"Under this plan the herd was rapidly reduced in numbers and full notes are herein inserted of all cases. Before this action a few had been sold as culls for shipment to reduce the herd. After discovery of the disease every animal was slaughtered if sold and notes made herein of its condition. Dr. E. A. A. Grange, State Veterinarian, conducted the examinations.

(Signed) "EUGENE DAVENPORT."

PROF. DAVENPORT'S REPORT OF CASES.

"*Phœnix 12* began to fail in health in the spring of 1890 and grew very bad. She was giddy by spells and poor and dull. She was slaughtered on suspicion April 23, 1890, and was affected with tuberculosis in the right lung. The liver seemed diseased, but the cause was not determined.

"Calf by her side was killed the next day. The calf had not been well, but no signs of tuberculosis were discovered upon post-mortem. It is supposed that this sickened condition was due to the milk of the mother, which had been very offensive for weeks.

"*Imperial Red Rose of Dervent.*—This cow rapidly lost flesh after the last calving. She had been examined by H. H. Hinds, President Live Stock Sanitary Commission, and Dr. Grange, State Veterinarian, and others, all of whom believed her to be tuberculous. Upon post-mortem examination she was found to be badly affected. One lung was grown to the side and tubercles as large as walnuts were found in the lungs. Portions of the lungs had broken down, which seemed to account for the coughing spells she had had weeks previous. This was the first animal slaughtered under the resolution of January 6, 1890, and it took place on the 7th of the month.

"A calf by her side was also slaughtered, but showed no signs of the disease.

"*College Victoria Duchess.*—This cow was thin in flesh for a long time, and all winter, spring and summer remained in a most unthrifty condition. She was slaughtered on suspicion of disease in pursuance of plan on October 17, 1890. No symptoms or evidence of tuberculosis were found on post-mortem examination by Dr. Grange. Great quantities of foreign matter were found in the second stomach, sufficient, in the doctor's opinion, to set up chronic inflammation of the parts. Many sharp pointed nails had pierced the walls of the stomach.

"*Phœnix 2* was sold to S. S. Olds of Lansing, March 23, 1887, but was returned to the College on his learning of her possible condition. She produced a calf in 1888 and aborted in 1889. She was fattened and slaughtered for beef March 1, 1890. On post-mortem examination the lungs and intestines were found badly affected with tubercles.

"*Helianthus 5.*—This animal had a swelling in the throat in the fall of 1889. During the winter it grew worse and affected his breathing. He was separated from the herd and ate well, but refused his drink. He discharged somewhat from the nostrils. When slaughtered the thyroid gland was found to be badly affected with tuberculous matter. The lungs and neighboring parts were also tuberculous.

"Late in the fall of 1889, *Miss Bates* commenced to decline in health and failed rapidly. For safety she was placed in the barn and it only hastened the decline. She was slaughtered on December 7, 1899, and both lungs were found adherent to her sides and nearly solid with tuberculous lesions. She was one of the worst cases found.

"*College Morley* was slaughtered for beef November 9, 1899. He was in fine flesh, but a large bunch on the left side of the neck, eight or nine inches in diameter, was found to be of a tuberculous nature. The lungs were also affected with tubercles.

"*College Red Rose 5* also showed tuberculous lungs.

"*Snow Bloom.*—Growing very old, this cow was slaughtered for beef February 7, 1891. Post-mortem examination showed slight deposits of tuberculous matter in the lungs.

"*Aaltje 2* had lost one-fourth of her udder and was fed for beef. On post-mortem examination both lungs were found affected with small tubercles as well as some large ones.

"*Louette* appeared dull during the summer of 1890. She commenced coughing and was attacked by a high fever of 105 degrees F. She was slaughtered October 17, 1890. Her right lung was almost solid from tuberculosis; her left lung was badly affected and also the liver. Her calf was slaughtered at the same time, but was found apparently sound.

"*Fennel Duke 2nd of Sideview.*—This bull, in the spring of 1890, was fed off and slaughtered on April 25. He had not fed well for a year, although he had always been a hard feeder. On post-mortem examination was revealed a tuberculous tumor about the size of a walnut in the right lung, near the base, close to the pulmonary glands. His cough, which he had previous to his slaughter, had probably been caused by a tumor in the trachea not of a tuberculous character."

From Prof. Davenport's report, it is evident that tuberculosis was extensively prevalent among the members of the College herd in the years 1889 and 1890. After the slaughter of the above cattle we find no records of tuberculosis in the herd. although we understand from those connected with the College at that time that there were grave suspicions of the disease existing. There is evidence of the persistency of this disease after the slaughter of the above animals, found in the swine register.

In March, 1891, a sow and boar were slaughtered and found to be tuberculous, by Dr. Grange. May, 1891, four sows were slaughtered and found to be tuberculous. In July of the same year, Dr. Grange post-mortemed four boars which were tuberculous.

The data given thus far reveals a very deplorable condition among the animals of the College farm during the early '90's, for which at that time no one could have been held responsible, because the tuberculin test was not yet known. The records do not show whether the disease was completely wiped out at that time. It is probably a fair inference to regard it as fairly checked in its worst stages, but by no means completely eradicated. What was left doubtless furnished the nucleus for the developments of 1896, when the herd was first tested with tuberculin. During the intervening time, between 1891 and 1896, the disease was slowly progressing, but in none of the animals had it reached such a stage as to manifest itself in any characteristic symptoms.

During the years 1893, 1894 and 1895 the character of the herd was changed from the beef to the dairy type, thus making it more essential that the tuberculin test be applied to ascertain whether tuberculosis existed, although there was nothing especially

indicative of the disease. This led to the establishment of the bacteriological work in connection with the experiment station.

Early in the year of 1896 the attention of the Board was called to the use of tuberculin as a test in diagnosing this disease. The Board placed the matter in the hands of President Snyder, Director Smith and Dr. Grange. These gentlemen unanimously agreed to apply the test to the College herd. This was done by Dr. Grange March 31 and April 1, 1896. Nine animals out of fifty-seven responded. Besides these, there were some which gave suspicious reactions. These were again tested on May 11 and 12 of the same year. Two of them gave distinct reactions. Again on August 19 and 20 Dr. Grange applied the tuberculin test to those still holding out as suspicious and found one reacting. In April of this year the Board granted Dr. Grange permission to hold these reacting animals for experimental purposes. On June 30 the Director of the Station communicated to the Board the general outline of experiments with this disease which has since been followed. In the spring of 1897, April 20 and 21, another test was applied to the whole herd, including the animals already condemned, by Dr. Grange. Five animals at this time responded to the test, in addition to those having already reacted. September 6 and 7, 1897, the author tested fifteen graded cows which had been purchased by the College for dairy animals. None responded to the test. October 13 and 14 I applied the test to fifteen more grade cows bought for the same purpose as the others, and found none reacting. At the same time, the test was applied to thirteen suspects remaining over and two reacted. March 31 and April 1, 1898, the annual test was again made of the whole herd and only one animal reacted in addition to those already condemned. When the annual test was applied in 1899, March 30 and 31, to the regular herd, one additional animal responded. Since this time there has been no test applied to all the animals.

The details of the test of each animal reacting, together with other interesting data, will be given under the history of the respective animals.

ROSA BONHEUR 5, 11227.

This cow had for her sire Meadow Brook Chief, 1969, and her dam Rosa Bonheur, 890, H. H. B., and was born March 20, 1888. Her breed is Holstein. She first reacted April 1, 1896. Her reactions at that time and since are as follows:

March 31, 1896, before injection, 99.0, 100.6, 100.8, 101.2, 100.8.

April 1, 1896, after injection, 100.2, 100.4, 100.6, 100.1, 101.6, 102.9, 103.3, 102.6, 102.6.

August 26, 1896, before injection, 99.0, 101.4, 101.8, 102.1, 101.6.

August 27, 1896, after injection, 101.6, 101.8, 101.6, 101.8, 102.1, 102.8, 104.0, 105.0, 104.4.

April 22, 1897, before injection, 101.5, 101.1, 101.0, 101.5, 101.4.

April 23, 1897, after injection, 101.0, 101.2, 101.2, 101.9, 101.1, 101.4, 104.6, 103.2, 102.8.

October 13, 1897, before injection, 100.5, 101.6, 101.3, 100.8, 101.7, 101.3, 102.2.

October 14, 1897, after injection, 101.2, 101.2, 101.4, 101.1, 101.1, 101.4, 102.0, 101.8, 101.5, 102.5, 102.3.

March 31, 1898, before injection, 99.7, 99.3, 97.7, 97.1, 97.2, 98.4, 97.9, 99.0, 98.6, 98.4.

April 1, 1898, after injection, 97.7, 99.3, 99.8, 98.9, 99.2, 96.9, 98.3, 96.7, 98.4, 97.8, 98.3, 98.0.

October 14, 1898, before injection, 100.2, 100.6, 99.0, 98.6, 100.0, 99.9, 100.4, 101.0, 99.8, 101.4.

October 15, 1898, after injection, 100.8, 99.0, 99.3, 100.0, 99.4, 99.0, 97.2, 99.7, 100.7, 100.0.

March 30, 1899, before injection, 97.8, 97.0, 98.5, 98.5, 99.3, 98.4, 97.4, 97.8, 97.8, 97.3.

March 31, 1899, after injection, 96.8, 98.9, 99.1, 100.9, 97.8, 97.4, 98.5, 98.4, 97.9, 99.2, 97.8, 97.0.

October 9, 1899, before injection, 99.5, 98.6, 100.0, 99.9, 100.2, 100.8, 99.8, 101.5, 101.4, 100.8.

October 10, 1899, after injection, 99.7, 99.6, 100.0, 100.3, 99.8, 100.1, 100.8, 100.4, 100.6, 100.5, 101.2.

It will be seen from these reactions that this cow did not respond to the tuberculin test after April, 1897.

At no time did her excreta or milk show the presence of tubercle bacilli. I was never able to secure sputum or nostril discharges which contained tubercle bacilli.

Her weight at no time decreased to such an extent as to cause anyone to suspect the presence of tuberculosis.

Of the calves dropped by her during this period, we have record of none responding to the test. One of her calves, College Rosa Bonheur, 37013, born February 6, 1894, responded to the test October 14, 1897. This would indicate a doubtless outside infection.

Having become lame in her stifle joints during the year 1899, and having reached the point where she was unable to rise after lying down, she was killed and subjected to post-mortem examination. Tubercles were found in the lung, mediastinal and bronchial glands, in the liver, spleen, portal glands, mesenteric glands and some lymphatic glands of the abdomen. There were three or four scars an inch to two inches in diameter on her liver, evidently the remains of former tuberculous abscesses. Some of the tubercles were in an active state, as demonstrated by inoculation upon guinea pigs. Others were apparently inactive, for when some of the material was introduced into guinea pigs, they remained untouched by the disease. The stifle joints had corroded to such an extent that the cartilagenous covering had completely disappeared from large areas. There was present large amounts of serous exudate and the tissues were edematous. Some of the serum was introduced into guinea pigs, but did not produce tuberculosis in these animals.

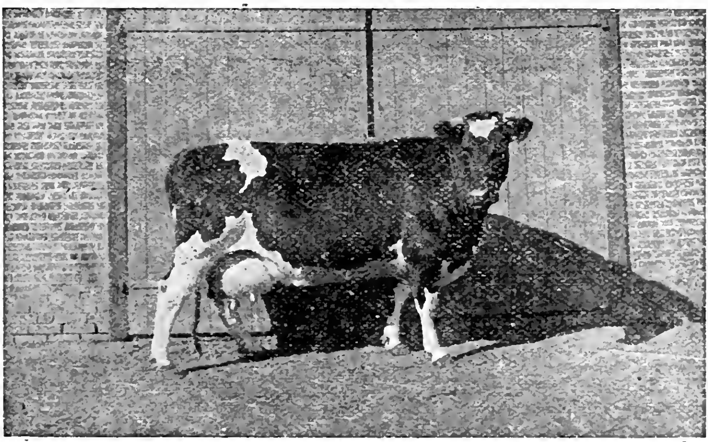
BELLE SARCASTIC, 23039.

The sire of this cow is Sarcastic, 4729, and her dam is Belvisia, 4553. She was born January 18, 1890, and is a Holstein. Her first reaction to the tuberculin test was April 21, 1897. All of her test temperatures are as follows:

April 20, 1897, before injection, 101.5, 101.2, 100.8, 100.6, 101.0.

April 21, 1897, after injection, 101.4, 101.6, 101.3, 102.1, 103.9, 106.1, 105.4, 106.1, 105.3, 104.2.

October 13, 1897, before injection, 99.2, 101.1, 101.7, 101.9, 101.5, 101.8, 100.9.



Belle Sarcastic.

October 14, 1897, after injection, 102.7, 100.9, 102.0, 101.2, 101.1, 100.8, 102.3, 101.6, 102.0, 102.4, 101.8.

March 31, 1898, before injection, 99.9, 100.3, 99.5, 97.3, 98.2, 101.9, 102.4, 100.6, 101.3, 103.9.

April 1, 1898, after injection, 101.9, 99.9, 100.4, 98.6, 98.7, 99.6, 98.2, 99.4, 98.4, 99.3, 98.9, 101.5.

October 14, 1898, before injection, 99.6, 99.2, 99.6, 99.4, 99.6, 98.7, 100.4, 99.8, 101.2, 101.2.

October 15, 1899, after injection, 101.4, 101.4, 100.8, 101.8, 102.9, 103.6, 101.9, 103.9, 103.2, 102.9.

March 30, 1899, before injection, 98.1, 98.2, 98.6, 98.2, 99.6, 98.9, 97.2, 99.0, 98.9, 98.9.

March 31, 1899, after injection, 100.0, 98.8, 100.0, 99.2, 99.2, 102.3, 101.6, 102.0, 102.8, 100.3, 99.4, 102.6.

October 9, 1899, before injection, 99.8, 100.3, 99.0, 100.2, 100.0, 101.2, 100.8, 102.0, 102.0.

October 10, 1899, after injection, 98.4, 100.4, 101.0, 100.6, 100.4, 100.4, 100.0, 99.8, 102.8, 103.0, 103.0, 104.7.

March 30, 1900, before injection, 100.5, 100.7, 99.2, 100.7, 101.2, 98.0.

March 31, 1900, after injection, 98.9, 100.4, 99.0, 100.5, 99.6, 100.3, 99.7, 99.9, 99.7, 100.6, 100.8.

Although this cow did not react at each test, it will be noticed, in looking over her reactions, that she is probably still susceptible to the tuberculin test. Her last reaction was last October.

She has never been known, in all the tests made of sputum, milk and excreta, to give off tubercle bacilli.

Her condition was good until about a year ago. When she dropped her last calf, there were signs of deterioration. This may, however, be due to the fact that she did not clean well. Since then she has improved greatly in appearance, although she has not yet become impregnated.

None of her calves since she has reacted have proved to be tuberculous. College Belle Sarcastic, 37016, dropped April 13, 1894, responded to tuberculin in the spring of 1899. Belle Sarcastic is still alive and doing well.

MYSIE 44, VOL. 25, P. 845.

She was the daughter of 5th Duke of Ackland, 51734, and Mysie, 43, vol. 25, p. 675. She was a Shorthorn. Her birth dates back to May 12, 1882. The first test, April 1, 1896, condemned this animal. Her temperatures are here given:

March 31, 1896, before injection, 100.6, 100.8, 100.7, 100.2, 100.0.

April 1, 1896, after injection, 100.4, 100.7, 102.4, 100.4, 104.0, 104.4, 102.8, 101.4.

August 26, 1896, before injection, 100.6, 100.9, 101.6, 101.3, 101.1.

August 27, 1896, after injection, 100.9, 100.9, 101.2, 102.0, 104.2, 104.2, 104.8, 104.4, 103.8.

April 22, 1897, before injection, 100.4, 100.8, 99.1, 100.2, 101.4.

April 23, 1897, after injection, 101.6, 101.6, 102.0, 101.3, 101.8, 102.8, 105.0, 103.1, 101.0.

All the above tests were positive.

Several examinations were made of the discharges from the nostrils of this cow, and in every case these discharges contained the tubercle bacilli.

Six examinations made of the milk from this cow were negative. In one case, the day before she died, her milk was put through a separator and the slime examined with negative results.

Several examinations of the urine always resulted negatively.

Her feces always contained tubercle bacilli. An experiment was carried out on some hogs to demonstrate the infectiousness of the fecal matter. On October 5, 1896, three hogs were placed behind this cow, two of which were fed with corn mixed with feces and one fed with corn alone. On the 29th of April, 1897, these hogs were killed. The two which had received the corn with feces had general tuberculosis and the one used as a control, placed in an adjacent pen, had during this time some communication with the two hogs behind the cow through the board wall which at one time yielded to their upturning propensities, and had likewise contracted the disease, but it was limited to the bronchial glands. A duplicate experiment was made. Four small pigs three or four weeks old were placed behind Mysie 44's stall and separated from the stall by a high partition. The pigs were then divided into lots of two each with a strong partition between, so as to avoid the error in experiment 1. The pigs of one pen received corn mixed with feces from Mysie 44. The pigs in the other pen acted as controls and received corn only. This experiment started June 5, 1897. On November 10, 1897, one of the pigs fed with feces and corn was found dead. It had been sick for several weeks, had become emaciated, its breathing was labored and it was very weak during the period of sickness. On post-mortem examination, general tuberculosis was found to exist. On November 12, 1897, the second and last pig of this lot, the one associated with the pig which died November 10, also succumbed. General tuberculosis existed in this pig. Of the two pigs acting as controls one was killed at the expiration of six months from the time it was started in this experiment and the other died December 10, 1897, of general tuberculosis.

Mysie 44.

There were no tuberculous lesions found in the one killed. It is a difficult matter to control such experiments when it is practically impossible under the circumstances to establish perfect isolation. Why one of these animals remained free from the disease and the other succumbed to it, although constantly associated, is a matter of speculation. The partition walls between the two pens remained tight during the time, so that the tubercle bacilli must have gotten to the control pigs through some other avenue.

Microscopical examinations of the feces made occasionally usually gave positive results.

While Mysie 44 was under observation she seemed to have periods of improvement and decline alternating with each other.

Of Mysie 44's offspring I have record of College Mysie 3d, vol. 37, p. 716, dropped February 13, 1891; College Mysie 4th, vol. 39, p. 602, dropped June 29, 1892; College Mysie 5th, vol. 40, p. 753, dropped March 23, 1893; College Mysie 6th, vol. 40, p. 753, dropped March 29, 1894, and her last calf dropped in March, 1896, which remained unnamed and unrecorded. Of these offspring only the calf unnamed is to be found in the list of tuberculous animals. Their histories will be recorded in another place.

Mysie 44th died September 5, 1897, after severe convulsions and muscular spasms. Two weeks previous to her death, nervous disorders were very noticeable, and a week before her death she suffered from an attack similar to that which caused her death. Besides the convulsions, there were muscular twitching and inability to control voluntary muscular movements, and apparently considerable pain, which was evidenced by marked groaning. Post-mortem examination was made with great care after her death. The spinal cord and brain were removed, but no tuberculous lesions could be found. In short, we could discover no pathological changes, either in the organs themselves or in the canal. The nervous symptoms were probably due to some changes in the nervous system beyond the reach of the naked eye. The posterior pharyngeal glands were normal. The lungs were decidedly tuberculous throughout. The bronchial and mediastinal glands were badly affected. Over the entire pleura were studded numerous tubercles from the smallest size which the eye could detect to the size of a walnut. The œsophagus, stomachs and intestines were followed the entire length without finding a trace of tubercle. A few of the mesenteric glands, however, were slightly diseased. The liver, spleen, kidneys and ovaries were absolutely free from the disease so far as our post-mortem revealed.

In this cow, where the tubercle bacillus was constantly found in the feces, it seems a little strange that the abdominal viscera were so free from the disease.

POLY'S BLOSSOM, 6376.

Her sire was Orient, 2567, and dam Polyander, 2328. She was born August 21, 1892, and belongs to the Guernsey breed. Her first reaction was April 1, 1896. The following are the records of the tests:

March 31, 1896, before injection, 101.1, 100.8, 101.4, 102.0, 101.0.

April 1, 1896, after injection, 102.0, 103.2, 104.9, 103.2, 105.2, 105.6, 104.3, 100.2, 102.5.

August 26, 1896, before injection, 99.7, 101.4, 101.6, 102.1, 101.6.

August 27, 1896, after injection, 105.5, 106.7, 106.8, 106.0, 106.1, 105.8, 106.6, 106.9, 106.2.

April 22, 1897, before injection, 99.6, 101.4, 100.7, 99.8, 100.4.

April 23, 1897, after injection, 103.0, 103.0, 104.6, 105.5, 105.1, 103.4, 103.0, 103.0, 103.0.

This cow reacted from the first and continued to react through the three tests. Previous to July 1, 1897, her milk was examined frequently, but in each case inoculations proved to be negative. After July 1, 1897, her milk was examined four different times with positive results.

From the time of her response to the test, her feces were subjected to examinations occasionally with negative results until July 17, 1897, at which time the examination gave positive results. From October 5, 1896, to April 28, 1897, two pigs were fed corn mixed with her feces without contracting tuberculosis.

The examination of her urine always yielded negative results.

I have record of only one calf from Poly's Blossom subjected to the tuberculin test. This calf was a grade which was dropped sometime during the year 1896 and had been allowed to run with the mother for several months. It was condemned April 22, 1897.

Poly's Blossom began to run down with the beginning of the year 1897. This may be shown by her weights at different times:

Date.	Weight.	Date.	Weight.
Feb. 2, 1897	885	July 16, 1897	648
March 2, 1897	837	July 17, 1897	627
April 2, 1897	836	July 18, 1897	630
May 2, 1897	818	July 19, 1897	623
June 2, 1897	803	July 24, 1897	600
July 2, 1897	755		

She was not weighed after this.

Her death occurred July 29, 1897. Her lungs were a solid mass of tubercles. Tubercles of various sizes occurred throughout the abdominal cavity, some were three inches in diameter. The lymphatic glands and the pleural and abdominal cavities were generally affected. The udder had begun to show signs of tuberculosis, but in the incipient stage.

AIDA 2, 6112.

She was the daughter of Orient, 2567, and Aida, 3318, and was born January 12, 1892. She was a Guernsey. She first reacted April 21, 1897. Her test records are:

April 20, 1897, before injection, 102.2, 101.7, 100.4, 100.1, 104.0.

April 21, 1897, after injection, 101.2, 100.7, 100.8, 101.4, 102.6, 105.4, 106.0, 103.7, 106.0, 104.4.

October 13, 1897, before injection, 101.6, 99.9, 101.6, 102.5, 102.3, 102.0, 101.6.

October 14, 1897, after injection, 104.2, 104.0, 103.7, 105.2, 105.3, 105.6, 105.4, 104.9, 104.6, 105.0, 104.4.

March 31, 1898, before injection, 100.0, 98.6, 98.1, 97.0, 98.6, 96.9, 98.6, 96.9, 96.9, 100.6.

April 1, 1898, after injection, 100.6, 100.9, 102.3, 101.4, 101.4, 101.6, 103.5, 101.9, 101.4, 99.1, 99.0, 99.0.

October 14, 1898, before injection, 100.2, 98.0, 98.3, 99.2, 100.8, 99.9, 98.5, 99.4, 99.6, 101.6.

October 15, 1898, after injection, 99.5, 99.6, 100.6, 103.1, 103.1, 102.6, 104.6, 103.2, 103.0, 102.6.

March 30, 1899, before injection, 99.8, 99.0, 97.8, 99.1, 98.4, 98.6, 96.1, 98.4, 99.6, 98.5.

March 31, 1899, after injection, 97.2, 99.1, 98.8, 98.4, 101.7, 99.6, 102.2, 102.9, 103.7, 103.0, 103.6, 100.7.

Of the several tests made for tubercle bacilli in her milk, I have secured only one positive result. This positive result, I am inclined to think, was probably due to the contraction of the disease by the guinea pig from other diseased guinea pigs. Although this seldom happens, in this case the evidence seems to favor such a conclusion, for the milk came from the right front quarter, and when tested several times after, it never set up tuberculosis. This was shown in another way. A litter of four pigs was taken, four weeks old, and separated into two lots of two each. To one lot was fed Aida's milk and some meal. To the other lot no milk was fed. The duration of this test was six months, at the end of which time all the pigs were killed, but none of them possessed any tubercles. This would help substantiate the above conclusion. In all probability, the one positive test was due to some outside contamination and her milk was free from tubercle bacilli.

Examinations of her feces, both microscopical and inoculative, always resulted negatively.

Her urine was always free from the virus of this disease, as demonstrated by repeated inoculations.

Her calves were College Cross, born November 2, 1896, and College Cross, born October 22, 1897, both of which were tested April 21, 1897, and April 1, 1898, respectively, but neither reacted.

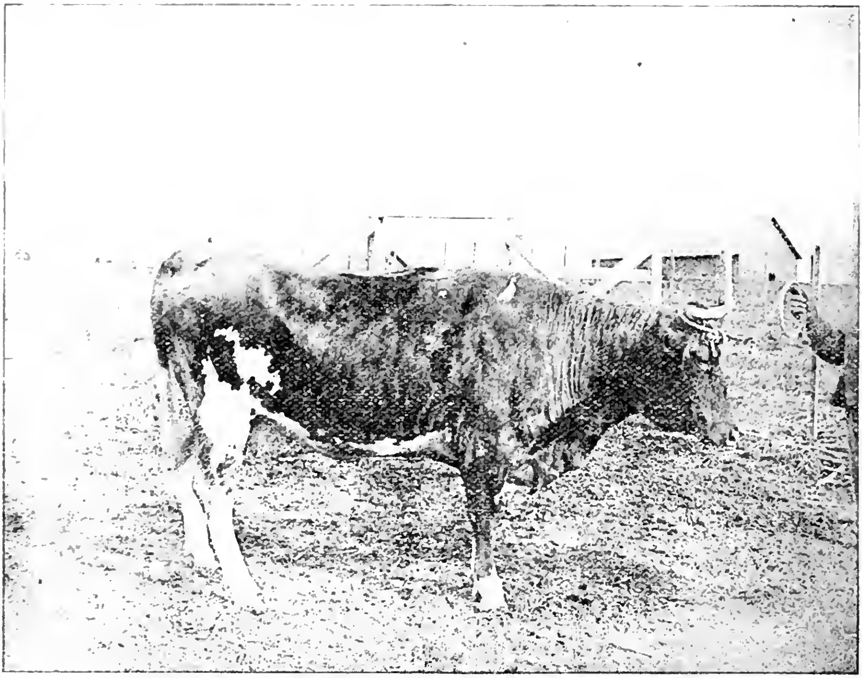
On April 18, 1899, Aida 2d was killed. At the time of killing she was in a very fair condition. The post-mortem examination revealed several hard, cheesy tubercles in the apex of one of her lungs and the adjacent tissue highly inflamed. The mediastinal glands had deposits of tuberculous calcareous material. A tuberculous mesenteric gland was also found.

COLLEGE CHAMEAULA.

This cow was the offspring of Orient, 2567, and Chameaula, 2126, and was born January 26, 1893. She belonged to the Guernsey breed. She was condemned April 1, 1896, and has the following test records:

March 31, 1896, before injection, 102.0, 101.3, 101.5, 101.4, 101.5.

April 1, 1896, after injection, 101.7, 103.2, 104.3, 109.8, 106.9, 106.1, 105.5, 105.0, 103.6.



College Chameaula.

August 26, 1896, before injection, 100.2, 101.9, 102.1, 102.4, 101.7.

August 27, 1896, after injection, 104.2, 105.1, 106.6, 105.8, 106.5, 105.9, 105.8, 106.0, 106.0.

April 22, 1897, before injection, 101.6, 100.8, 101.6, 101.0, 100.6.

April 23, 1897, after injection, 105.2, 104.0, 105.4, 105.9, 105.7, 104.8, 104.8, 105.0, 104.8.

October 13, 1897, before injection, 99.9, 100.3, 102.2, 100.9, 101.3, 102.0, 99.5.

October 14, 1897, after injection, 102.4, 102.4, 102.5, 103.0, 103.2, 103.9, 104.4, 103.6, 103.1, 101.7.

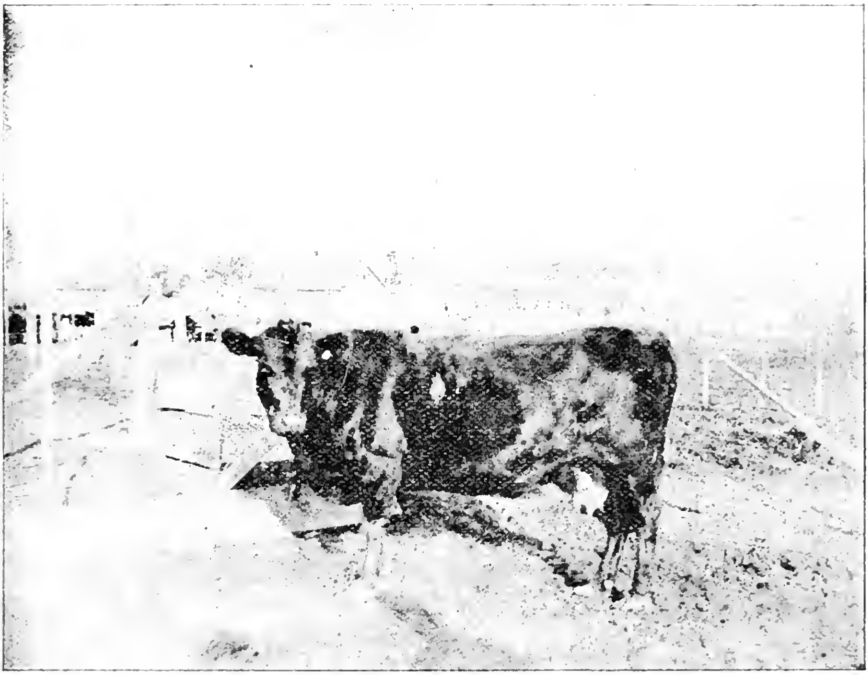
Occasional tests of milk, urine and feces yielded only negative results. Pigs were fed with corn mixed with her feces for six months, but did not contract the disease. I find no calves from this cow reported as having been subjected to the tuberculin test.

This cow was slaughtered December 14, 1897. Upon post-mortem examination, the mediastinal and bronchial glands were affected. Tubercles were scattered throughout the lungs and the apex of each lung was badly diseased. There were some tubercles to be found upon the pleura. The animal was in excellent condition when killed.

BARONESS OF TERLINGTON, 14,483.

The offspring of Day Star, A. M. 5307, and Nellie of Hilhurst, 4918, was born December 30, 1890, and belonged to the Aberdeen-Angus breed. Her first response to the test was April 1, 1896, and her test record is as follows:

March 31, 1896, before injection, 101.2, 101.0, 100.2, 100.3, 100.8.
April 1, 1896, after injection, 101.0, 100.6, 102.0, 103.0, 105.4, 105.9, 103.8, 104.7, 104.8.
August 26, 1896, before injection, 100.8, 101.8, 101.4, 103.0, 101.8.
August 27, 1896, after injection, 102.1, 103.0, 102.6, 103.4, 103.4, 103.6, 103.6, 104.4. 103.3.
April 22, 1897, before injection. 101.3. 101.7, 100.6, 100.9, 100.5.
April 23, 1897. after injection. 101.6. 102.1, 102.4, 102.9, 101.8, 101.0, 101.2, 102.2, 102.0.



Baroness of Terlington.

October 13, 1897, before injection, 102.2, 102.5, 102.5, 102.5, 102.8, 101.9, 101.3.
October 14, 1897, after injection, 100.4, 101.7, 101.8, 101.3, 100.6, 100.9, 101.2, 101.5. 101.6, 101.5, 102.2.
March 31, 1898, before injection, 99.7, 100.6, 98.5, 98.3, 98.8, 99.4, 98.7, 99.6, 99.4, 99.4.
April 1, 1898, after injection, 99.1, 99.1, 98.6, 99.8, 100.2, 99.1, 99.4, 100.3, 99.0, 99.9. 100.0, 100.1.
October 14, 1898, before injection, 101.2, 100.7, 100.2, 100.1, 99.9, 100.0, 100.0, 97.2. 100.6, 100.4.
October 15, 1898, after injection, 99.9, 100.4, 100.0, 100.4, 99.3, 100.1, 100.6, 99.0, 99.8, 100.1.
March 30, 1899, before injection. 99.5. 99.2. 99.0, 99.2, 98.7, 99.3, 98.7, 99.0, 99.1, 99.1.
March 31, 1899, after injection 98.1, 99.4, 99.6, 98.0, 101.3, 102.7, 102.5, 101.6, 101.9, 100.7, 102.4, 102.9.

It will be readily seen from the above figures that this cow gave no distinct and satisfactory reaction after August 27, 1896, although the tests of April 23, 1897, and March 31, 1899, show reactions of an irregular type. The tests between the two last dates, three in number, gave no reactions at all. There is some significance, too, in the fact that in the two unsatisfactory reactions mentioned, the temperature did not rise above 102.9, and on October 13, 1897, her normal temperatures ran high and in one instance to 102.8. Such discrepancies in temperatures should have their weight in testing animals, and, it seems to me, point to the necessity of keeping the records of tested

herds. The temperature history of each animal may then be reviewed before any judgment is pronounced.

The milk, urine and feces from this cow always proved to be free from tubercle bacilli. Even the pigs fed with corn mixed with her feces for six months did not become tuberculous.

College Blue Boy, born May 6, 1895; Baroness Boy, born September 23, 1896; a female calf born December 22, 1897, represent the offspring of the Baroness of Terlington. All were tested one or more times, but none responded. The last was allowed to run by the mother's side for a year, but did not contract the disease. It is a peculiar characteristic of the temperatures of these calves that they possess a great variability. The normal temperatures in various instances were as high as 103.

Baroness of Terlington was killed April 18, 1899. On post-mortem examination, only the posterior pharyngeal glands showed signs of disease. The tuberculous material was of a hard calcareous and yellowish condition, surrounded by a dense, fibrous covering. Some of this material was introduced into a guinea pig intra-peritoneally. Five months afterward the guinea pig was killed and was free from tuberculosis. Inasmuch as this cow had not reacted for two years in a satisfactory manner, it may be possible that the disease was in a stage of decadence. She was very fat and sleek when killed.

COLLEGE VICTORIA B, VOL. 37, P. 716.

Volunteer, 101,205, was her sire, and College Victoria, vol. 31, p. 793, was her dam. She was born February 16, 1891, and was a Shorthorn. The tests placed her among the tuberculous animals April 1, 1896, but she never responded afterward. Through all this time she remained in prime condition and gave no signs of tuberculosis. I call attention to this before giving her test records:

March 31, 1896, before injection, 99.8, 101.0, 100.8, 101.0, 101.2.

April 1, 1896, after injection, 101.4, 100.6, 101.7, 100.9, 101.1, 100.8, 102.8, 103.5, 102.5.

August 26, 1896, before injection, 100.6, 100.7, 100.9, 102.1, 101.7.

August 27, 1896, after injection, 101.0, 100.8, 101.3, 100.9, 101.1, 101.4, 101.2, 102.0, 101.4.

April 22, 1897, before injection, 101.8, 100.7, 101.4, 100.9, 100.1.

April 23, 1897, after injection, 101.5, 101.5, 101.2, 100.4, 100.6, 100.6, 100.6, 101.6, 101.0.

October 13, 1897, before injection, 101.6, 99.9, 100.9, 101.2, 101.4, 101.0, 101.4.

October 14, 1897, after injection, 100.6, 100.3, 99.9, 99.9, 99.8, 100.4, 101.0, 100.8, 101.0, 101.9, 101.7.

March 31, 1898, before injection, 95.6, 98.6, 99.3, 100.2, 97.9, 98.2, 99.4, 99.8, 99.0, 97.3.

April 1, 1898, after injection, 99.8, 99.2, 97.0, 100.5, 99.6, 100.0, 101.3, 99.4, 99.5, 100.3, 99.6, 99.1.

March 30, 1899, before injection, 101.1, 100.2, 100.0, 101.6, 100.3, 101.3, 100.0, 99.6, 100.1, 100.2.

March 31, 1899, after injection, 98.5, 99.9, 100.2, 100.8, 99.9, 100.8, 101.0, 99.2, 100.6, 100.0, 100.1.

After the first test, these temperatures show no indications of tuberculosis. The milk, urine and feces tested microscopically and by inoculation and feeding experiments with pigs, in no case gave positive results.

Her offspring, a male, born November 19, 1895, and College Queen, born December 21, 1896, both of which were tested, gave no response.

College Victoria B is still alive and in a thrifty condition, so far as known.

The fact that College Victoria B was the daughter of College Victoria, which died of tuberculosis, may lend some color to the susceptibility of this branch of the family, although there is not sufficient ground for acceptance.

COLLEGE VICTORIA C, VOL. 39, P. 602.

Volunteer, 101205, was her sire, and College Victoria, vol. 31, p. 793, was her dam. She was born January 3, 1892, and belongs to the Shorthorn breed. She first reacted to tuberculin April 21, 1897, and has the following test records:

April 20, 1897, before injection, 101.2, 101.5, 100.9, 100.9, 100.6.

April 21, 1897, after injection, 100.7, 101.0, 101.4, 102.0, 102.1, 103.7, 103.5, 103.0, 103.8, 103.4.

October 13, 1897, before injection, 101.7, 100.5, 102.2, 102.6, 103.0, 103.3, 103.3.

October 14, 1897, after injection, 102.3, 103.3, 102.2, 103.1, 103.2, 103.1, 103.0, 104.1, 104.2, 104.6, 103.7.

March 31, 1898. before injection, 99.8, 99.9, 99.2, 99.4, 98.6, 100.2, 99.1, 98.8, 99.4, 99.6.

April 1, 1898, after injection, 97.4, 99.4, 100.0, 99.2, 98.8, 99.6, 98.7, 100.0, 98.2, 98.3, 100.3, 99.8.

October 14, 1898, before injection, 99.6, 100.4, 98.8, 100.3, 100.1, 100.2, 99.8, 100.6, 100.6, 100.9.

October 15, 1898, after injection, 99.6, 100.2, 99.6, 99.9, 99.4, 99.7, 100.2, 99.8, 100.4, 100.4.

March 30, 1899, before injection, 98.8, 98.8, 99.6, 99.2, 99.6, 99.0, 98.4, 99.3, 99.6, 99.6.

College Victoria C.

March 31, 1899, after injection, 98.8, 100.1, 98.6, 99.0, 99.6, 99.2, 98.8, 98.7, 99.6, 100.2, 100.4, 98.6.

October 9, 1899, before injection, 99.6, 160.8, 99.6, 100.0, 101.0, 100.9, 101.6, 102.0, 101.8, 102.0.

October 10, 1899, after injection, 100.4, 99.0, 99.8, 101.1, 100.4, 100.0, 101.4, 100.6, 100.8, 100.8, 101.6.

In reviewing the above tests, there seems to be a striking response in the first and in the second. It is very marked, but is peculiar in that the normal temperatures reach 103.3 degrees and the temperatures after injection 104.6 degrees. This makes a difference of 1 3-10 degrees, which, according to the arbitrary methods of regarding 2 degrees difference as necessary for condemnation, would not be considered condemnatory, yet these two sets of temperatures are indicative of tuberculosis. When taken in connection with the tests following, there is some doubt cast upon such a diagnosis.

No signs of tubercle bacilli have ever been found in the excreta, in the milk or nostril discharges.

She has never had the appearance of being diseased, has always maintained her flesh and is at the present time in the best of conditions.

We have test records of her offspring, College Volunteer, born June 18, 1895; College Royal, born October 29, 1896; College Royal 2d, born October 22, 1897, and a calf born in 1899, but none of them have given any response to tuberculin.

CARA (NO. 9), 8393.

Cara is the offspring of Bower Baron, 1466, and Bower Belle, 6208. She was born July 27, 1893, and was of the Red Polled breed. She was condemned October 14, 1897, and her tests are:

October 13, 1897, before injection, 101.1, 100.0, 99.6, 100.8, 101.0, 100.5, 101.3, 100.4, 100.9.

October 14, 1897, after injection, 103.2, 103.0, 103.2, 102.9, 103.0, 104.4, 104.1, 103.8, 102.8, 102.6, 103.1.

March 31, 1898, before injection, 98.6, 99.2, 99.4, 97.8, 97.6, 97.2, 100.8, 99.3, 97.9, 97.9.

April 1, 1898, after injection, 100.4, 97.7, 98.9, 99.6, 97.3, 98.5, 97.7, 101.2, 99.6, 101.9, 101.7, 101.3.

October 14, 1898, before injection, 100.0, 100.6, 100.4, 99.9, 100.7, 100.7, 100.5, 102.4, 101.3, 101.2.

October 15, 1898, after injection, 100.4, 100.1, 101.3, 101.1, 99.8, 99.2, 100.4, 99.9, 100.7, 101.7.

March 30, 1899, before injection, 98.4, 98.4, 97.4, 99.2, 97.4, 99.2, 99.1, 98.0, 97.8, 98.7.

March 31, 1899, after injection, 98.5, 100.7, 98.4, 100.5, 102.1, 97.5, 98.7, 97.6, 98.2, 100.0, 99.0, 97.0.

October 9, 1899, before injection, 100.2, 99.7, 100.3, 99.4, 101.0, 100.6, 100.4, 100.3, 100.6, 100.9.

October 10, 1899, after injection, 101.0, 99.6, 99.2, 101.2, 101.1, 99.4, 101.0, 99.5, 100.6, 100.5, 99.8.

May 8, 1900, before injection, 102.0, 100.4, 99.6, 99.4, 100.8, 100.8, 100.6, 101.0, 100.0, 99.4.

May 9, 1900, after injection, 99.8, 99.2, 98.2, 98.4, 98.2, 98.3, 99.6, 98.3, 99.7, 99.2, 99.2, 99.5, 99.4.

Tested twice before October 13, 1897, and five times afterwards, leads one to suspect that the reaction of October 14 was due to some cause other than tuberculosis. This is borne out also by the post-mortem examination which after careful research revealed no tuberculous lesions. This examination occurred May 21, 1900.

COLLEGE POGIS, 75078.

This cow was a Jersey, born from Lily's Nero, 19041, and Pogis Barronne, 52272, on the 11th of May, 1890. She was condemned April 21, 1897, and has the following test records:

April 20, 1897, before injection, 100.8, 101.0, 101.3, 100.8, 101.6.

April 21, 1897, after injection, 102.8, 103.9, 105.4, 106.7, 106.3, 106.4, 107.2, 107.1, 106.3, 105.4.

October 13, 1897, before injection, 100.7, 100.6, 100.1, 100.0, 100.2, 100.1, 100.4, 100.3.

October 14, 1897, after injection, 101.6, 101.3, 102.8, 105.5, 106.1, 105.6, 104.7, 105.4, 105.7, 105.9, 105.7.

March 31, 1898, before injection, 98.6, 99.1, 98.8, 97.8, 98.5, 99.8, 98.6, 97.4, 98.4, 98.9.

April 1, 1898, after injection, 97.6, 98.6, 99.2, 99.5, 99.5, 98.8, 99.7, 101.3, 102.1, 103.0, 101.0, 102.1.

October 14, 1898, before injection, 99.2, 98.6, 99.8, 99.5, 99.1, 100.4, 99.6, 101.6, 99.9, 100.3.

October 15, 1898, after injection, 97.9, 100.2, 100.6, 100.6, 99.4, 99.5, 99.5, 99.6, 101.3, 100.6.

March 30, 1899, before injection, 97.6, 97.9, 97.9, 98.3, 98.3, 98.6, 99.2, 99.2, 98.4, 98.6.

March 31, 1899, after injection, 98.0, 98.7, 98.3, 99.0, 101.6, 98.7, 99.7, 99.4, 99.4, 100.4, 99.2, 99.8.

Of the above five tests, two gave characteristic reactions. Her milk, feces and urine were occasionally subjected to examination without any positive results.

During this time her appearance was healthful and she was in good flesh.

Her offsprings were College Pogis 2d, 101777, born November 18, 1892; College Pogis 3d, 125892, born October 20, 1895; College Pogis 4th, 125896, born April 13, 1897, which were subjected to the tuberculin test. None of them were found tuberculous.

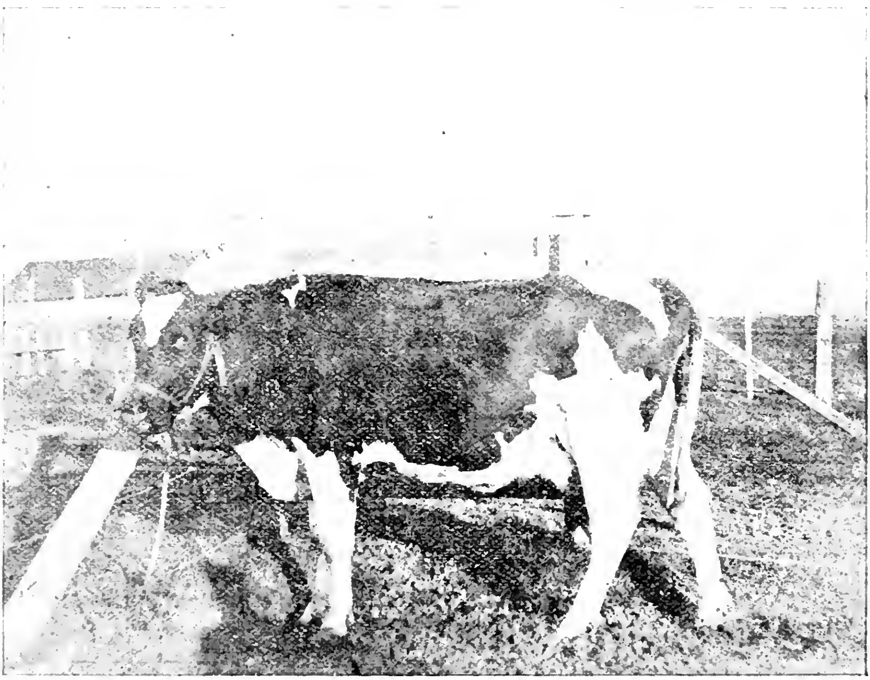
College Pogis was slaughtered April 18, 1899. The mediastinal gland was involved and the tuberculous material calcareous. White spots were found on the liver tissue. Material taken from the mediastinal gland and injected into guinea pigs produced tuberculosis, but the material taken from the liver and introduced into guinea pigs failed to produce tuberculosis.

COLLEGE ROSA BONHEUR, 37013.

Her sire was Maurice Clothilde, 17638, and her dam was Rosa Bonheur 5th, 11227. She was born February 6, 1894, and belonged to the Holstein breed. She first reacted to tuberculin October 14, 1897. Her test records are:

October 13, 1897, before injection, 99.3, 100.2, 100.6, 101.2, 100.8, 101.4, 101.3, 101.1, 101.6.

October 14, 1897, after injection, 101.4, 101.9, 103.2, 103.0, 104.4, 104.6, 103.1, 101.8, 101.4, 101.4, 102.0.



College Rosa Bonheur.

March 31, 1898, before injection, 99.7, 98.9, 97.5, 96.7, 97.3, 98.5, 99.7, 100.4, 100.0, 100.6.

April 1, 1898, after injection, 98.6, 98.1, 98.0, 100.1, 98.3, 96.7, 97.5, 97.5, 98.7, 99.2, 99.3, 98.5.

October 14, 1898, before injection, 100.6, 99.1, 99.7, 100.0, 100.9, 99.7, 100.8, 100.8, 101.1, 101.3.

October 15, 1898, after injection, 100.0, 101.0, 100.8, 100.4, 99.8, 100.2, 100.2, 100.5, 100.9, 100.9.

March 30, 1899, before injection, 98.3, 97.8, 98.4, 98.9, 99.4, 99.0, 99.6, 98.4, 98.4, 98.5.

March 31, 1899, after injection, 99.0, 99.2, 99.2, 99.1, 98.5, 97.4, 99.2, 97.9, 100.0, 98.6, 100.9, 97.0.

October 9, 1899, before injection, 100.8, 100.6, 99.9, 101.0, 101.8, 101.8, 100.7, 101.3, 101.6, 101.2.

October 10, 1899, after injection, 100.4, 99.3, 99.8, 99.7, 100.5, 100.1, 100.4, 100.2, 100.8, 100.4, 100.6.

Only once did this cow respond to the tuberculin test.

Neither her milk nor excreta ever gave positive results upon examination for tubercle bacilli.

We have tested of her offspring, Bonheur Boy, born September 4, 1896; Bonheur Boy 2d, born September 4, 1897, and a female calf, none of which responded to the test.

College Rosa is apparently in a healthful condition at the present time.

COLLEGE BELLE SARCASTIC, 37016.

The sire of this cow was Maurice Clothilde, 17638, and her dam was Belle Sarcastic, 23,039. She was born April 13, 1894. She belongs to the Holstein breed. Her first reaction occurred March 31, 1899, and her test records are as follows:

March 30, 1899, before injection, 100.4, 99.0, 100.5, 101.0, 99.0, 99.1, 100.8, 100.4, 100.2, 101.0.

March 31, 1899, after injection, 102.3, 102.0, 100.8, 101.2, 103.1, 103.5, 102.6, 101.2, 102.4, 100.4, 100.7.

October 9, 1899, before injection, 98.5, 98.0, 99.2, 99.0, 99.5, 99.6, 99.4, 99.8, 100.6.

October 10, 1899, after injection, 99.4, 99.8, 99.0, 100.2, 100.4, 98.7, 99.8, 99.4, 99.4, 100.3, 99.8.

March 30, 1900, before injection, 102.0, 98.0, 100.1, 100.3, 100.4, 99.7.

March 31, 1900, after injection, 100.4, 99.8, 99.8, 99.9, 100.0, 98.3, 100.6, 100.1, 99.6, 99.1, 100.9.

Only one response to the test is apparent. Since the time of this reaction there has been no evidence of tuberculosis. On March 28, 1898, the normal temperatures of this cow were 106.4, 104.7, 104.2, 102.4, 102.5, 103.9, 102.8, 102.8, 101.6. No visible diseased condition was present at the taking of these temperatures. She is a very nervous cow, but this does not account for the above high temperatures.

The examination of the excreta from this cow has never revealed the presence of tubercle bacilli.

She is still alive and looks well.

College Belle has sometimes had periods of flesh reduction, but I am inclined to think that it was due to the care rather than to any diseased condition.

Of her calves, College Belle Sarcastic's Boy, born August 13, 1897, and a calf born in 1898, have been tested, but neither has given any response to tuberculin.

COLLEGE DAME LE BROCQ II, 100522.

This cow has for her sire Lily's Nero, 19041, and her dam, Dame Le Brocq, 54075. She was born March 27, 1894, and is a Jersey. Her test records are:

August 19, 1896, before injection, 101.0, 100.7, 101.6, 101.5.

August 20, 1896, after injection, 100.8, 101.2, 101.6, 101.4, 101.6, 102.6, 102.9, 103.4, 102.7, 102.6, 102.0.

April 22, 1897, before injection, 100.0, 100.7, 101.1, 100.4, 101.2.

April 23, 1897, after injection, 101.0, 100.0, 101.6, 101.3, 102.4, 104.6, 104.4, 104.8, 104.0.

October 13, 1897, before injection, 101.6, 100.9, 101.7, 101.5, 102.0, 102.2, 101.6.

October 14, 1897, after injection, 103.1, 101.9, 102.4, 103.3, 104.0, 104.5, 105.3, 105.8, 105.6, 105.8, 105.1.

March 31, 1898, before injection, 98.7, 99.7, 98.7, 99.9, 98.5, 99.5, 99.1, 99.9, 99.1, 99.3.

April 1, 1898, after injection, 100.1, 99.3, 98.8, 98.7, 98.9, 98.9, 100.2, 101.2, 101.6, 100.8, 101.2, 102.6.

At no time did this cow give off tubercle bacilli in her milk, urine or feces so far as the various tests demonstrated.

Her calves, College Dora, 125894, born May 6, 1896, and another born December 24, 1897, were both tested, but failed to respond.

College Dame Le Brocq II was killed August 8, 1898, and subjected to post-mortem examination. There were a few large tubercles scattered through the lungs. The posterior mediastinal gland was affected and a lymphatic gland found near the anus was also affected, otherwise the tissues were apparently free from the disease.

COLLEGE WHITE BOY.

His sire was Volunteer, 101205; his dam College Duchess IV, vol. 35, p. 772. He was born March 29, 1894, and was a Shorthorn. He was condemned August 19, 1896, and has the following test records:

August 19, 1896, before injection, 101.6, 101.4, 101.3, 101.4.

August 20, 1896, after injection, 104.2, 104.0, 103.5, 103.3, 103.1, 103.1, 103.3, 104.4, 103.6, 103.5, 103.6.

April 22, 1897, before injection, 100.7, 101.2, 100.8, 100.9, 100.6.

April 23, 1897, after injection, 100.2, 100.5, 101.0, 100.8, 100.6, 100.6, 101.2, 101.2, 100.1.

This animal was slaughtered May 11, 1897, shortly after the last test. After the most careful examination, no trace of tuberculosis could be found.

CALF OF MYSIE, 44.

This calf was the offspring of Volunteer, 101205 and Mysie 44, vol. 25, p. 845. She was born during March, 1896, and belongs to the family of Shorthorns. She was condemned April 1, 1896, and she has the following test records:

March 31, 1896, before injection, 100.8. 101.2, 101.5, 101.9, 101.0.

April 1, 1896, after injection, 102.7, 102.9, 104.4, 103.8, 103.8, 104.4, 103.6, 103.5.

August 26, 1896, before injection, 100.5, 100.6, 101.8, 102.2, 101.6.

August 27, 1896, after injection, 101.2, 101.2, 101.6, 101.3, 101.6, 101.3, 102.0, 102.5. 102.3.

April 22, 1897, before injection, 101.0, 101.5, 101.4, 102.2, 102.6.

April 23, 1897, after injection, 102.0, 101.0, 101.5, 102.0, 102.4, 102.4, 101.6, 101.2.

October 13, 1897, before injection, 99.6, 99.4, 101.9, 101.6, 101.8, 101.3, 100.5.

October 14, 1897, after injection, 104.4, 105.2, 105.2, 105.4, 105.7, 105.3, 105.2, 104.7, 104.4, 104.0, 102.5.

Examination of the feces and urine at no time revealed the presence of tubercle bacilli.

This calf was housed continuously and was never able to seek the open air. It manifested this treatment very markedly, for it never did well and never possessed a good coat.

It was killed October 26, 1897. Upon examination, the right posterior pharyngeal, mediastinal, bronchial, several mesenteric and portal glands were affected. The lungs were free from the disease. Of all the glands affected, the mesenteric appeared to be the worst.

POLY'S BLOSSOM'S CALF.

She was the offspring of Poly's Blossom, 6376. Her sire is unknown. The date of birth is not recorded. She was allowed to run with her mother for several months and was condemned April 23, 1897. The test records are as follows:

April 22, 1897, before injection, 102.4, 101.5, 101.3. 101.2, 100.4.

April 23, 1897, after injection, 103.2, 105.0, 105.4, 105.2, 104.8, 105.2, 105.0, 105.0. 103.6.

October 13, 1897, before injection, 98.8. 99.5, 102.0, 101.5, 102.2, 101.4, 101.4.

October 14, 1897, after injection, 106.2, 104.4, 104.9, 105.1, 105.6, 104.9, 105.1, 105.6, 105.0, 104.8, 104.1.

I was never able to find tubercle bacilli in the feces or urine of this calf.

This calf was killed October 26, 1897. The bronchial gland was tuberculous and the liver was covered over with tubercles.

CALF OF COLLEGE DAME LE BROCQ, 79449.

The sire of this calf was Rettas Averroes, 3519. She was born September 11, 1895. and belonged to the Jersey breed. She was first condemned April 1, 1896, and her test records are:

March 31, 1896, before injection, 100.4, 101.3, 100.4, 101.2, 102.6.

April 1, 1896, after injection, 101.9, 102.7, 103.0, 103.5, 104.3, 105.6, 106.0, 105.6.

August 26, 896, before injection, 101.1, 101.1, 102.2, 102.2, 101.7.

August 27, 1896, after injection, 101.6, 102.3, 104.1, 105.0, 104.4, 102.7, 105.1, 104.7. 104.0.

April 22, 1897, before injection, 102.4, 100.5, 101.0, 101.3, 100.6.

April 23, 1897, after injection, 101.0, 100.5, 100.4, 100.9, 101.4, 101.8, 101.6, 101.4, 101.2.

October 13, 1897, before injection, 101.5, 100.5, 102.1, 102.6, 102.6, 100.8, 102.0.

October 14, 1897, after injection, 105.2, 104.9 104.9, 105.5, 105.7, 105.7, 105.9, 105.4, 105.0, 104.0, 104.1.

March 31, 1898, before injection, 99.9, 100.3, 97.8, 99.2, 98.6, 100.4, 99.6, 101.3, 99.7. 99.7.

April 1, 1898, after injection, 99.7, 98.8, 99.3, 100.3, 99.5, 99.3. 99.8, 103.3, 102.8, 102.7. 102.8, 101.6.

October 14, 1898, before injection, 99.6, 99.4, 99.3, 100.7, 99.9, 100.6, 100.3, 100.0, 98.4, 100.6.

October 15, 1898, after injection, 102.4, 102.9, 103.0, 102.9, 102.0, 102.2, 101.2, 100.1, 101.6, 100.5.

March 30, 1899, before injection, 100.0, 99.9, 100.2, 99.0, 99.7, 100.5, 100.2, 100.0. 100.6, 99.9.

March 31, 1899, after injection, 100.5, 100.2, 100.1, 98.5, 100.2, 99.2, 100.0, 110.1, 101.6, 100.8, 101.4, 98.5.

The urine and feces of this animal never revealed the presence of any tubercle bacilli.

A calf born to this animal became very much emaciated and stunted while running with his mother. He was killed March 25, 1898, but no traces of tuberculosis could be found. His condition appeared to be due to malnutrition.

This cow was killed on April 18, 1899, and subjected to post-mortem examination. She was in fair condition when killed. The mediastinal and bronchial glands were affected and there was a large tubercle beneath the stomach.

COLLEGE MYSIE VII, VOL. 40, P. 753.

Volunteer, 101255, was her sire, and College Mysie VII was her dam. She was born July 29, 1895. She was a Shorthorn. She was first condemned April 21, 1897, and her test reactions are as follows:

April 20, 1897, before injection, 101.5, 101.0, 101.5, 100.9, 101.4.

April 21, 1897, after injection, 101.2, 102.4, 104.0, 105.0, 105.1, 105.6, 105.9, 105.4, 105.2, 104.9.

October 13, 1897, before injection, 100.8, 101.2, 101.8, 101.8, 101.7, 102.0, 101.2.

October 14, 1897, after injection, 100.8, 101.7, 101.8, 101.4, 101.3, 100.9, 102.3, 102.8, 102.1, 103.0, 102.5.

March 31, 1898, before injection, 98.2, 98.8, 98.8, 99.5, 98.0, 100.0, 98.8, 97.8, 100.5, 99.2.

April 1, 1898, after injection, 98.9, 98.4, 98.6, 98.7, 100.9, 100.6, 101.6, 102.4, 102.1, 101.0, 101.2, 101.8.

October 14, 1898, before injection, 99.7, 100.6, 100.0, 100.0, 100.8, 100.9, 101.5, 101.1, 101.2, 100.8.

October 15, 1898, after injection, 100.2, 102.6, 104.1, 104.3, 104.8, 104.6, 104.4, 104.0, 103.2, 104.0.

March 30, 1899, before injection, 98.0, 98.8, 99.2, 99.2, 100.7, 99.0, 98.0, 98.0, 99.6, 100.2.

March 31, 1899, after injection, 100.6, 99.3, 100.6, 102.0, 102.2, 103.4, 102.0, 100.0, 99.1, 100.3, 100.0, 102.6.

This cow never showed the presence of tubercle bacilli in urine or feces.

Her appearance was aways healthful until the spring of 1899, when she began to run down and breathe with difficulty. She was slaughtered April 18, 1899. There was a large tubercle in her throat fully four inches in diameter, which probably caused the difficulty in breathing. Her lungs contained numerous tubercles of various sizes. No tubercles were found elsewhere in her body.

GRADE COW NO. 111.

This cow was purchased by the College as one of the grade dairy herd during the summer of 1897. When brought to the College she was tested but did not react. In the spring of 1898 she was again tested and gave the following temperatures:

March 31, 1898, before injection, 101.0, 101.2, 101.1, 100.7, 100.0, 99.9, 100.0, 100.0, 98.1, 97.4.

April 1, 1898, after injection, 100.8, 99.7, 100.5, 102.1, 102.8, 104.4, 104.8, 104.5, 104.0, 103.2, 101.6, 100.6.

She was killed after the test and found to be affected with general miliary tuberculosis.

COLLEGE VICTORIA, VOL. 31, P. 793.

Her sire was Col. Acomb 2, 37984, and her dam was College Victoria Duchess 2, vol. 23, p. 17798. She was born January 29, 1886, and was a Shorthorn. College Victoria was tested in the spring of 1896 and gave the following temperatures:

March 31, 1896, before injection, 102.1, 102.8, 102.7, 103.0, 102.4.

April 1, 1896, after injection, 104.6, 104.8, 104.7, 104.5, 103.4, 104.4, 104.0, 102.6, 103.0.

She declined rapidly after this test and soon died of general tuberculosis. Her offsprings which have a test record are College Victoria B, vol. 37, p. 716, and College Victoria C, vol. 39, p. 602, both of which have given responses to tuberculin and both of them, especially College Victoria C, remain somewhat questionable as to their affliction with tuberculosis.

College Victoria.

COLLEGE CORBETT 2.

Jim Corbett was his sire and Cara, 8393, was his dam. He was born July 7, 1895, and belonged to the Red Polled breed. He gave the following reaction to tuberculin May 12, 1896:

May 11, 1896, before injection, 103.4, 101.9, 101.8, 101.5, 101.8, 101.6.

May 12, 1896, after injection, 102.4, 103.5, 103.3, 104.1, 104.4, 105.6, 105.2, 106.0, 105.2, 104.9, 103.3, 103.7.

This animal was slaughtered some time after this test and found to be sound.

NETHERLAND VAN FRIESLAND BEETS, 236724.

This cow was the offspring of Netherland von Friesland, 10822, and Anna Beets, 2680, A. R. 110. She was born July 11, 1890, and was brought here from Pontiac, after having been tested and condemned by Geo. W. Dunphy, V. S., State Veterinarian. After arriving here she was placed with the tuberculous animals in a separate stall and pasture lot and the tests were continued at six months' intervals. Her records while here are as follows:

March 31, 1898, before injection, 98.2, 98.8, 98.8, 99.5, 98.0, 100.0, 98.8, 97.8, 100.5, 99.2.

April 1, 1898, after injection, 98.9, 98.4, 98.6, 98.7, 100.9, 100.6, 101.6, 102.4, 102.1, 101.8, 101.2, 101.8.

October 14, 1898, before injection, 99.5, 97.5, 98.2, 99.2, 100.5, 99.0, 99.8, 99.6, 101.4, 97.8.

October 15, 1898, after injection, 100.1, 98.6, 99.4, 97.7, 100.0, 99.9, 101.5, 98.7, 103.5, 102.9.

March 30, 1899, before injection, 99.0, 98.2, 98.7, 98.0, 97.4, 97.8, 97.0, 96.8, 97.0, 97.2.

March 31, 1899, after injection, 98.9, 97.8, 95.5, 97.2, 99.1, 100.2, 100.4, 103.5, 102.1, 101.0, 100.5, 101.2.

When this cow was received here she was very poor and seemed far gone with tuberculosis. She, however, regained her flesh and appeared very well.

Her milk, feces and urine were repeatedly examined for tubercle bacilli, but all results were negative.

She was slaughtered April 18, 1899. There were only the slightest traces of tuberculosis found in the liver and mesenteric glands of this cow.

Of the foregoing animals the test records were given from and including the first response given to tuberculin. Any tests made before reaction in several of the cows mentioned were omitted because we did not think that such tests would have any serious weight upon our conclusions. In every case there was either one or more responses to the tuberculin. The table that follows will show the numbers of reaction to tuberculin of each of the preceding aimals, as well as the number of tests made from and including the first response:

Name of animal.	No. of tests.	No. of reactions.
Rosa Bonheur 5	8	3
Belle Sarcastic	7	4
Mysie 44	3	3
Poly's Blossom	3	3
Aida 11	5	5
College Chameaula	4	4
Baroness of Terlington	7	3
College Victoria B	6	1
College Victoria C	6	2
Cara	6	1
College Pogis	5	3
College Rosa Bonheur	5	1
College Belle Sarcastic	3	1
College Dame Le Brocq 11	4	4
College White Boy	2	1
Calf of Mysie 44	4	2
Poly's Blossom's Calf	2	2
Calf of College Dame Le Brocq	7	5
College Mysie 7	5	5
Grade Cow No. 111	1	1
College Victoria	1	1
College Corbett 2	1	1
Netherland von Friesland Beets	3	3

Of the cows giving the reaction more than once, we have been unable to find one free from tuberculosis upon post-mortem examination. Not all, it is true, of these have been slaughtered and examined. There still remain alive College Victoria C and Belle Sarcastic which have reacted more than once to tuberculin.

Of those which have been tested more than once and have reacted only once to tuberculin, Cara and College White Boy have been killed, and both of them were found free from tuberculosis so far as the eye could detect upon post-mortm examination. College Victoria B, College Rosa Bonheur, College Belle Sarcastic are still alive and we are unable to prophesy whether they will remain free from tuberculosis or not. Animals which have been tested once and reacted once are excluded from this summary.

So far as this table goes, it indicates that one response to tuberculin cannot always be taken as a safe criterion in determining the presence of tuberculosis.

Our next table will note the presence or absence of tubercle bacilli in sputum, milk, urine and feces of the several animals. The examinations were microscopical and inoculative. Guinea pigs were the animals used for inoculation.

— = Negative results, no tubercle bacilli found.
+ = Positive results, tubercle bacilli found.
0 = No examination.

Name of animal	Sputum.	Milk.	Urine.	Feces.
Rosa Bonheur 5	—	—	—	—
Belle Sarcastic	—	—	—	—
Mysie 44	+	—	—	+
Poly's Blossom	+	+	—	+
Aida II	—	—+	—	—
College Chameaula	—	—	—	—
Baroness of Terlington	—	—	—	—
College Victoria B	—	—	—	—
College Victoria C	—	—	—	—
Cara	—	—	—	—
College Pogis	—	—	—	—
College Rosa Bonheur	—	—	—	—
College Belle Sarcastic	—	—	—	—
College Dame Le Brocq	—	—	—	—
College White Boy	—	0	—	—
Calf of Mysie 44	—	0	—	—
Poly's Blossom's Calf	0	0	—	—
Calf of College Dame Le Brocq	0	0	—	—
College Mysie 7	+	—	—	—
Grade Cow No. 111	0	0	0	0
College Victoria	0	0	0	0
College Corbett 2	0	0	0	0
Netherland von Friesland Beets	—	—	—	—

In the following table, the calves found to be tuberculous at birth or soon after are enumerated.

Name of animal.	No. of tuberculous calves.	Remarks.
Rosa Bonheur 5	None	
Belle Sarcastic	None	
Mysie 44	One	Calf associated with mother.
Poly's Blossom	One	Calf associated with mother.
Aida II	None	
College Chameaula	None	
Baroness of Terlington	None	
College Victoria B	None	
College Victoria C	None	
Cara	None	
College Pogis	None	
College Rosa Bonheur	None	
College Bell Sarcastic	None	
College Dame Le Brocq	None	
Calf of College Dame Le Brocq	None	
College Victoria	None	

In only two cases were calves found to be tuberculous soon after birth. Both of these had been associated with their mothers from the time they were dropped until tested. When a calf was born to the other cows, it was always removed immediately, thus avoiding as much danger from infection as possible.

In looking over these records, there will be found some of the offspring of these tuberculous animals contracting tuberculosis, but this usually happens after they are a year or two or even several years old. This therefore demonstrates that the infection does not come from the mother, but from some outside source. We may safely conclude, therefore, as others have concluded before us, that the young may be raised from tuberculous animals without much danger of their contracting the disease.

Taking into consideration the post-mortem examinations and then referring to a previous table, wherein are found data concerning the sputum, milk, urine and feces, we note a relationship between advanced tuberculosis and the dissemination of this disease through the nostrils, milk or excreta. In the case of Mysie 44 and Poly's Blossom we find nearly all of the danger, if examinations may be used as our basis of judgment, and that there is little possibility of disseminating the disease when it is in its incipient stages. This, however, does not eliminate the danger to any degree, but on the contrary demonstrates that most of the tuberculous virus radiates from few centers. It is possible for one animal to infect a herd of a hundred animals or more and it illustrates also how essential it is to know whether such a breeding center is present in a herd.

The work thus far shows how easy it is to practically eradicate the disease if proper measures are adopted. The first test was made in the spring of 1896, when there were numerous reactions, and the last test was made in 1899, when there was a single reaction, and that was doubtful. The same is true of others following this system. This leads us to the consideration of the management of this disease.

MANAGEMENT OF TUBERCULOSIS.

No subject offers so many difficulties as this and none opens more fully the way for criticism. The reasons for this state are to be found in our ignorance of the many details of tuberculosis. We may feel as though we were well acquainted with this disease after such prolonged study, extending over fifteen years, yet when we approach a discussion of the applicability of our scientific knowledge, we waver somewhat, because of an insecure feeling in our convictions. Tuberculosis is present with us, is a drastic disease, it affects man and beast alike, it demands attention, consequently some means are called for in its management. Whatever method is in vogue at the present time or may even be suggested in the near future, must be looked upon as not necessarily permanent, but the best that may be recommended under present conditions.

Every country has already adopted methods of fighting this disease or is preparing to adopt some method which will control it. Commission after commission has been appointed to review the subject and to determine upon the best plans. When we cast our eyes over the various methods employed or suggested, there is a marked unity of thought, although the execution may differ widely. To approach a fair understanding of what is involved in such a subject as this, the mind must be made free from prejudice and cant, and must endeavor to seek only the truth as it is presented and apply it in honesty. Individual fears or suspicions should have no weight when determining a course to pursue. I desire to treat this matter, first, as a private individual having stock, and second, to regard the disease as subject to the control of the State.

Let us assume that we have a large herd of well bred stock or even a native herd of considerable value, located in Michigan at the present time. We may or we may not suspect tuberculosis, but we know that tuberculosis exists quite commonly in the State. Regardless of what the law says, let us consider what our duty, as a private individual, is toward the herd concerned.

We know that if tuberculosis is present in the herd, the disease will sooner or later be scattered and will affect other members of the herd which are now sound. In the next place, if no tuberculosis is present, it will be possible to so manage the herd as to keep it out. Either reason, it seems to me, is of sufficient consequence to warrant the testing. In testing, it may be desirable to do it quietly and not necessarily make it the property of the whole community or of the State, for publicity does not help the matter in any way. It is very desirable to secure a man who has had considerable experience, because he will be able to interpret results to better advantage than the man who has had no experience. The mechanical act is not difficult if once learned thoroughly, but beware lest some failure in performance creep in. Before the fly season appears in the spring time, the test may be conducted with greater ease and better success.

Late in the fall is also a favorable time. How to conduct the test will be found in my bulletin 159, of this station.

Should any of the animals react, it becomes a question how to dispose of them. This is necessarily an individual question in several respects. In the first place, does the disease show physical signs? In the second place, how valuable is the animal? In the third place, is it desirable to keep this animal for breeding? In the fourth place, can this animal be fattened for the market? If there are any physical symptoms manifested by the animal, in all probability the disease has advanced to such a stage that it would be unsafe to keep the animal longer for breeding purposes and has become so generalized that the carcass cannot be used as food. We have had such animals in the College herd. Mysie 44, Poly's Blossom, College Mysie VII, and perhaps two or three others, were very dangerous animals to have about. It makes a great difference whether an animal possesses any intrinsic value and whether its keeping will bring any pecuniary returns or not. There are some animals which it would not pay to keep for breeding or to fatten for beef, consequently it were better to kill them on the spot. I wish to repeat right here, however, that repeated tests may prove the animal to be all right. This I have brought out in previous tables. It is frequently the case that a cow possesses sufficient value to keep her for breeding purposes, even if the offspring do not pay for her keeping; it will doubtless be cheaper in the end to hold her until a new herd is started. In this way, where large herds have almost been riddled by tuberculosis, the old herd has been kept until the offsprings have reached a stage to take the place of the old herd. The milk with proper pasteurization may be freely used. Animals which have responded to the tuberculin test may frequently be fattened advantageously and placed upon the market subject to inspection. If any local lesions are present, the meat may be used with little danger. It should, however, aways be marked as such so people will know what they are buying. This will, of course, require competent inspectors who will see to the proper management of such carcasses.

Any animals which possess sufficient worth for isolation should be kept until a second test, at least, may be applied. With the second test, there will be little doubt of the animals which react the second time. When isolation is practiced, it should be as nearly perfect as is possible. The feeding and watering should be independent and in separate receptacles. If practicable, the same man who does the work for the sound herd should not do the work for the condemned herd. Any calves dropped by cows in isolation should be removed as soon as possible after birth. This isolation should be continued as long as reacting animals are upon the premises. At no time is it desirable and under no circumstances, to send a reacting animal back to the sound herd. When they have lost their value in isolation, fatten them and slaughter them, subject to inspection.

It is the wiser plan to remove the sound animals after a test and leave the reacting animals where they are. This is not always practicable. Usually it is necessary to remove the reacting and leave the sound. Disinfection of the barn must therefore follow. For the disinfection of barns and stables, I refer the reader to bulletin 172 of this station. In this bulletin I have prepared methods of disinfection.

To pasteurize the milk, it will be necessary to heat every particle to 85 degrees C. momentarily, or 68 to 70 degrees C. for twenty minutes. If tuberculosis of the udder is suspected, it is very dangerous to use the milk even when pasteurized, for particles of tuberculous material will find their way into the milk and will not yield to the pasteurization.

After a herd has been tested, animals which have been purchased for introduction into the herd should always be placed in quarantine for two weeks and during that time should be tested with tuberculin. It would be utter folly to test one's herd and then undo the work by introducing animals without any notion whether they have tuberculosis or not. There is another side to this also. If our leading stock-growers should demand that all purchased animals be free from tuberculosis, there would soon be a sentiment which would place tuberculosis upon a sound footing. Its dissemination, by this act alone, would be practically checked, for it would not get beyond the centers where it is now located.

The above is a method which is practically the same as Bang's and has been found to be very successful, if such a thing as success may be attached to the handling of tuberculosis. By this method, it becomes possible to eradicate the disease, to build up the herd, to obtain the largest returns from a diseased herd and to secure safety to the public. I believe it to be economical for the stock-grower to ascertain the tuberculous status of his herd as soon as convenient, for by so doing, he either finds that he has no tuberculosis present or he discovers its presence before, in most

cases, it has gained a firm footing. Once knowing its presence, it is possible to check it by intelligent, persistent and systematic treatment.

What attitude the State should bear toward the eradication of tuberculosis may be many sided, but inasmuch as the State is bound to protect its citizens against disease as well as against crime, if it lies within its power, and to protect the property of its citizens, it must be a duty of this State to accomplish as much as is possible in ridding itself of tuberculosis. Thus far, we must all be agreed. Most of the states of the Union have, in one way or another, manifested their interest in tuberculosis. In other diseases of the human family and of cattle, they have done much toward restriction. Why is it not possible, therefore, to restrict tuberculosis?

We find such states as Maine, New Hampshire, Connecticut, Rhode Island, Pennsylvania and others require that all animals entering the State must be submitted to the tuberculin test. France, Belgium, Denmark and Canada are some of the countries that also follow this custom. Such a provision of the State law may tend to check the disease in a small way, but where so much of the disease is found within the borders of the State, unless there is great importation, this method must fail to be a very important factor. It is true that if cattle used for breeding could be subjected to the tuberculin test before entering the State, there would be much gained, and yet we believe that nearly every stockman who is sufficiently progressive to import blooded stock will be progressive enough to have his importations tested before taking them into his herd. If this is not done, the stockman runs a very serious risk. If stock-feeders bring stock into the State simply for the purpose of feeding and then turn them back to the large slaughtering houses of Chicago or elsewhere, where they are subjected to government inspection, the necessity for testing with tuberculin these beef animals is not so apparent. Again, if these same animals came from states where the disease is more rife than in Michigan, there would be some cause for testing, but most of these animals come from the western states where there is less tuberculosis, consequently the percentage of tuberculosis will not be increased. It is usually true, also, that the neighboring states adjacent to our borders possess about the same percentage of tuberculosis among cattle as our own State. They are all fighting with about the same degree of intensity as Michigan and will doubtless overcome the disease as rapidly as this State. With the exception, therefore, of imported breeding cattle which may be taken care of in another manner, there is no great need of placing barriers about Michigan. When the generality of tuberculosis is taken into account, the testing of imported cattle seems to be of questionable utility; however, the international importations are so comparatively few that it may be wise to place this check. Denmark, possessing thirty to forty per cent of tuberculous cattle, tests imported cattle from a country having only fifteen per cent. The wisdom is only seen in the rare possibility of some imported tuberculous animal getting into a herd free from tuberculosis, and this we maintain is a matter which the individual stock-grower should be held responsible for. He should either demand that the animal be tested before purchased or he should test the animal himself. If there were places of entry for animals passing from one state to another, this plan might also be feasible. International exchange has this advantage. But it does not seem feasible and it does not seem possible that the results would satisfy the expense account, to establish interstate quarantine, so that it will be effective.

The State management of tuberculosis within its borders is a matter of considerable importance. The farmer cannot be held responsible at the present time for tuberculosis in his herd and the State, on the other hand, is responsible for the health of its citizens, consequently it becomes a problem of adjustment between farmer and State. The State cannot with equity step in and destroy the property of the farmer wantonly without due compensation, and the farmer cannot demand of the State that it take the tuberculous animals off his hands and pay him for the same. The State would not be right in making a demand of the farmer that he test his cows, even, or the farmer demand of the State that it test his cows. It seems, therefore, that as long as it is a matter of adjustment, each should assume part of the responsibility. The State on its part should be willing to furnish the services of a competent man for testing, to furnish the tuberculin and to assist the farmer by means of competent meat inspectors and instructions in the management of tuberculous animals, while the farmer on his part should permit his herd to be tested, those animals showing physical signs of the disease to be slaughtered and those which still look vigorous to be maintained in isolation for breeding purposes or fattened and killed for the market, subject to inspection by competent inspectors. This should be a voluntary agreement between farmer and State. This can be economically accomplished only through a competent State officer who will have authority to appoint competent deputies in various parts

of the State to do this work. The farmer would, therefore, usually receive some compensation for the cattle, although he would not obtain the value of sound cattle, those which had general tuberculosis being, of course, a total loss. In this method, I have embodied the main features of the methods adopted by the European countries and have eliminated many of the pernicious features of some of the laws of our own states which have been proved impracticable.

Denmark adds two very important items by requiring that all milk passing through a public dairy or cheese factory should be pasteurized to 85 degrees C. momentarily, and that cows possessing tuberculous udders should be killed. The former checks the spread of the disease through the feeding of tuberculous milk to calves, the latter lessens the possibility of tuberculous milk.

I believe much can be done by the milk consumers of the State in placing dairy herds on a proper footing. The consumers, by paying a little more for the milk, may demand that they have milk from tuberculin tested cows, or more generally speaking, sound cows. But the milk consumers must not expect to increase the cost of producing milk and impose that cost wholly upon the milk producer, for there is little enough profit in the production of milk at the ordinary prices. If milk consumers cannot pay more than five or six cents per quart, for milk delivered at their houses in the city, they themselves, by their own penuriousness, invite infection.

I wish to acknowledge the supervision of Prof. E. A. A. Grange in this work until the fall of 1897, at which time he severed his connection with the College.

CHARLES E. MARSHALL.

Department of Bacteriology and Hygiene, June 21, 1900.

LITERATURE CONSULTED.

Armsby—Bulletin 21, Pennsylvania State College Agricultural Experimental Station.
Bryce—Report on Tuberculosis in Ontario (1894).
Bang—Congres pour et de la tuberculose (1898).
Bang—(Translation)—Bulletin 41, Hatch Experiment Station, Mass.
Craig—Journal of Experimental Medicine, Vol. III, p. 363.
Creighton—"Bovine Tuberculosis in Man." London, 1880.
Chiais—Congres pour et de etude la tuberculose (1898).
Dinwiddie—Bulletin 57, Experiment Station, Arkansas.
Ernst—Report to the Trustees of the Massachusetts Society for the Promotion of Agriculture.
Ernst—Bulletin 8, Hatch Experiment Station, Mass.
Grange—Report of Live Stock Sanitary Commission (Mich.), 1895 and 1896.
Jones—Cent. f. Bakt. Bd. XIII (1893), S. 697.
Cent. f. Bakt. Bd. XVII (1895), S. 1 u. 70.
Cent. f. Bakt. Bd. XX (1896), S. 393.
Klebs—Cent. f. Bakt. Bd. XX, No. 14 u. 15, S. 488.
Law—Bulletin 65, Agricultural Experiment Station of Cornell University.
Law—Bulletin 150, Agricultural Experiment Station of Cornell University.
Marpmann—Cent. f. Bakt. Bd. XXII (1897), S. 582.
McClintock—Paper read before the Detroit Medical and Library Association.
Novy—Communicability and Prevention of Tuberculosis.
Neff—American Journal of Insanity, Vol. LV, No. 3 (1899).
Nelson—Bulletin 101, New Jersey Agricultural College Experiment Station.
Nocard—"The Animal Tuberculoses." Translation.
Alsen—Cent. f. Bakt. Ab. II, Bd. III (1897), S. 273.
Paige—Massachusetts Agricultural College Experiment Station.
Paige—Bulletin 27, Massachusetts Agricultural College Experiment Station.
Report of Commission on Tuberculosis in Cattle of the State of New York (1895).
Report of New Hampshire Board of Cattle Commissioners, 1897 and 1898.
Report of the Board of Cattle Commissioners (Mass.) for 1895, 1898 and 1899.
Russell—Bulletin 40, Wisconsin Agricultural Experiment Station.
Russell—Bulletin 78, Wisconsin Agricultural Experiment Station.
Reynolds—Bulletin 51, Minnesota Agricultural Experiment Station.
DeSchweinitz—15th Annual Report, Bureau of Animal Industry.
Smith—Journal of Experimental Medicine, Vol. III, p. 451.
Thomassen—Congres pour et de etude la tuberculose (1898).
Teachers' Sanitary Bulletin, Vol. II, No. 10, October, 1899, Mich.
Veterinarian, Vol. LXVII, p. 882.

FERTILIZER ANALYSIS.

BY R. C. KEDZIE.

Bulletin 185.—Chemical Department.

Analyses of commercial fertilizers and license for their sale were not required in Michigan before the year 1885. Free trade of the widest scope was the practice up to that date. Any person having any substance supposed to have fertilizing quality could offer it for sale without hindrance in this State. Dealers in other states could send in material of small value, but with a catching name, and offer it for sale at such rates as to drive out fertilizers of real value but costing more. The cheats of lower cost and least value could drive out the fertilizer of greater cost and of real value. The average farmer could not tell with certainty from the physical appearance of various fertilizers which was the most valuable and which was not worth buying at any price.

A crisis arose at the Michigan State Fair when two manufacturers offered a "Superphosphate Fertilizer" for the prize. The committee to award the prize had no knowledge of the chemical composition of these two superphosphates, having nothing to guide their opinion but the physical properties of the two materials, reasoned thus: "Here is a superphosphate of light color and no odor, and for all we can see just as good as the other in other properties, while the other superphosphate is black colored and has an offensive odor. Let us give the first prize to the white and inoffensive superphosphate, and the second prize to the black and stinking stuff."

But the manufacturer of "the black stuff" would consent to no such award, appealed from the decision of the committee and demanded a chemical analysis of both the superphosphates to determine which was the real, and which the false superphosphate. [Genuine superphosphate contains phosphoric acid readily soluble in water, while common phosphate of lime is insoluble in water. The phosphoric acid that is soluble is much more active and valuable as a fertilizer.] Specimens of the two superphosphates were sent here and analyzed by Robert F. Kedzie, then assistant in chemistry, who found that the white and odorless superphosphate did not contain any phosphoric acid soluble in water—was in no sense a superphosphate, but consisted mainly of leached ashes and soap-boilers' waste; while the "black stuff" was a genuine superphosphate, having a large amount of soluble phosphoric acid, and still holds a good place in the market.

WHY A FERTILIZER LAW WAS PASSED.

A few experiences of this kind, reinforced by discovering that inert materials were being shipped into our State and sold as fertilizers at prices out of all proportion to their value, and the knowledge that fertilizers rejected in other states because of low values could still be dumped upon our markets, the farmers left to the mercy or avarice of dealers, honest or unscrupulous as the case might be, led to a demand on the part of both consumers and honest manufacturers of commercial fertilizers for a law which would compel a statement of the fertilizing materials contained in any commercial manure costing more than $10 a ton. The demand was primarily to protect the farmer and fruit-grower from imposition—to enable them to know the kind and quality of the materials they buy for fertilizers; in the second place the aim was to protect the honest manufacturer from the competition of unscrupulous manufacturers and dealers whether in this State or in other states.

These considerations caused the enactment in 1885 of a "law providing for the inspection of commercial fertilizers and to regulate the sale thereof." This law is to protect the consumer and to shield the honorable manufacturer from dishonest competition. It was not framed for the benefit of the Agricultural College, or to increase its patronage. A fee is exacted from the manufacturer or dealer to defray the expense of gathering the specimens for analysis in the open market (thus securing the material as actually offered for sale), and to pay for the analysis and other

expenses connected with the inspection. Any money from the inspection fees, in excess of these expenses, does not go to any officer or into the College treasury, but is placed in the Experiment Fund, and is used to obtain additional information for the public. It is thus seen that the manufacturer pays the bills and the consumer gets the benefit.

SOME OBJECT TO PAYING THE FEE AND TAKING OUT THE LICENSE.

It is manifest to every thinking person that the only just and proper way for the College is to enforce the law equally upon all who are liable to its claims. To allow some parties to escape the requirements of the law and to enforce them upon others is unfair and unjust. If the law is wrong let it be repealed, and "the best way to repeal an unjust law is to enforce it."

Parties seek to evade the law in various ways, a few of which will be noticed:

1. "I will pay the fee and take out a license when I have established a profitable trade in your State, but until then I want to sell my fertilizer without a license." If this privilege is conceded to one it should be to all, and practically there would be no inspection in this State.

2. "I do not sell enough of my fertilizer to pay the cost of the license." Then he had better keep out of the business in Michigan.

3. One dealer received a quantity of fertilizer which had been licensed, and then proceeded to sell this under several different names, such as "Onion Fertilizer," "Cabbage Fertilizer," "Potato Fertilizer," etc., etc., all out of the same barrel, leading his customers to suppose they were buying fertilizers of different qualities and especially fitted for these different crops. The law requires "a license fee of twenty dollars for each and every brand of fertilizer he offers for sale in this State." The explicit wording of the law soon disposed of this cunning cheat.

4. "What I sell is not a fertilizer but a chemical—Nitrate of Soda—and is sold as a chemical in the drug stores, and is not liable to the license fee as a fertilizer." The superphosphate is also a chemical: so too are sulphate of potash and sulphate of ammonia. When they are sold and used as fertilizers they all belong to the same class and must pay the fee and take out the license: otherwise the fruit-grower would have no assurance of the purity of these materials and their value when used as fertilizers. In other states they are classed and treated as fertilizers.

OBJECT OF INSPECTION OF COMMERCIAL FERTILIZERS.

The law does not prescribe any standard for the composition of a commercial fertilizer, the manufacturer being free to make his own standard, the law simply requiring that the fertilizers offered for sale shall be up to the standard set up by the manufacturer. The license to sell does not certify to the value of the fertilizer, but simply states that the manufacturer or dealer offers for sale a fertilizer for which a certain content of nitrogen, potash and phosphoric acid is claimed, and that samples of such fertilizers have been deposited with the secretary of the College with affidavit regarding the composition. Analysis is then made of each of these fertilizers, gathered in the open market as far as possible, and the results of such analysis published in bulletin. The *claimed* composition and *found* composition are arranged in parallel lines so that the real composition can be compared at a glance with the composition claimed for it by the manufacturer. In this way the buyer can see at once by this bulletin whether the fertilizer is as good as it claims.

To find the market value, calculations can be made on the basis that available nitrogen is worth fourteen cents a pound, soluble or available phosphoric acid four and a half cents, insoluble phosphoric acid two cents, and potash from four and one-half to six cents, according as it is in the form of chloride or sulphate. These prices are determined each year by the prices of substances from which these materials are derived in the great commercial centers, e. g., New York and Baltimore.

The composition is given in parts in one hundred. To obtain the number of pounds in a ton multiply the per cent by twenty. If we multiply the number of pounds in a ton by the price of each material the sum will give the value of a ton of fertilizer.

In the preparation of this bulletin most of the chemical analyses have been made by L. H. Van Wormer, B. S., the assistant in chemistry in the experiment station.

R. C. KEDZIE,
Chemist of Experiment Station.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1900.

Results of analysis of commercial fertilizers

Manufacturer.	Trade name.	Dealer and locality.
Abbott & Martin Rendering Co., Columbus, O.	Bone, Meat and Blood Guano	Manufacturer
Armour & Co., Chicago, Ill.	Fruit and Root Crop Special	W. O. Rhead, Hudson
Armour & Co., Chicago, Ill.	Star Phosphate	Manufacturer
Armour & Co., Chicago, Ill.	Phosphate and Potash	B. F. Pixley, St. Joseph
Armour & Co., Chicago, Ill.	Wheat, Corn and Oats Special	Manufacturer
Armour & Co., Chicago, Ill.	Bone, Blood and Potash	E. J. Sharp, Jackson
Armour & Co., Chicago, Ill.	Ammoniated Bone and Potash	Manufacturer
Armour & Co., Chicago, Ill.	Grain Grower	A. H. Whitehead, Lansing
Armour & Co., Chicago, Ill.	All Soluble	Farmers' Elevator Co., Lenox
Armour & Co., Chicago, Ill.	Bone Meal	Manufacturer
James Boland, Jackson	Blackman	James Boland, Jackson
Bradley Fertilizer Co., Cleveland, O.	Dissolved Bone with Potash	H. L. Atherton, Hudson
Bradley Fertilizer Co., Cleveland, O.	Niagara Phosphate	H. L. Atherton, Hudson
Bradley Fertilizer Co., Cleveland, O.	B. D. Sea Fowl Guano	H. L. Atherton, Hudson
Bradley Fertilizer Co., Cleveland, O.	Alkaline Bone with Potash	John Cope, Ubly

for 1900, expressed in parts in a hundred.

	Available nitrogen. Estimated as ammonia.	Phosphoric acid. Available.	Phosphoric acid. Insoluble.	Phosphoric acid. Total.	Potash soluble in water, estimated as K_2O.
Claimed	2.40—3.60	8—10	1—2	9—12	4—5
Found	2.79	8.63	1.42	10.05	3.53
Claimed	2 —3	8—10	1½—2½	9½—12½	5—6
Found	2.59	9.71	2.12	11.83	6.60
Claimed	....	12—16	2—3	14—19	....
Found	....	17.5	1.09	18.66	....
Claimed	....	10—12	2—3	12—15	2—3
Found	....	9.33	6.25	15.58	2.91
Claimed	1 —2	7— 9	2—3	9—11	1—2
Found	1.51	10.34	1.99	12.33	1.78
Claimed	5 —6	8—10	1½—2½	9½—12½	7—8
Found	5.48	9.87	1.13	11.00	6.66
Claimed	3 —4	6— 8	1½—2½	7½—10½	2—3
Found	3.8	8.47	2.64	11.11	2.49
Claimed	2 —3	8—10	1½—2½	9½—12½	2—3
Found	1.98	9.22	2.84	12.06	3.87
Claimed	3½ —4½	8—10	1½—2½	9½—12½	4—5
Found	3.58	8.93	2.62	11.55	4.68
Claimed	3 —4	....	....	24—28	....
Found	4.98	13.99	9.43	23.42	....
Claimed	1.14	3.86	2.06	5.94	2.51
Found	.85	4.62	1.50	6.12	4.48
Claimed	1.21—2.42	5— 6	2—3	7— 9	2—3
Found	1.56	7.67	1.16	8.83	3.29
Claimed	1 —2	5— 6	1—2	6— 8	1—2
Found	1.13	7.11	1.13	8.24	1.27
Claimed	2½ —3½	5— 6	2—3	7— 9	1½—2½
Found	3.13	9.07	.97	10.04	2.03
Claimed	....	6— 7	1—2	7— 9	2—3
Found	....	10.84	2.41	13.25	2.76

Results of analysis of commercial fertilizers for 1900,

Manufacturer.	Trade name.	Dealer and locality.
Bradley Fertilizer Co., Cleveland, O.	Soluble Dissolved Bone........	Manufacturer................
Chicago Fertilizer Co., Chicago, Ill..	Standard Truck Fertilizer......	Lewis Stead, Utica...........
Chicago Fertilizer Co., Chicago, Ill..	Wheat Special..................	Lewis Stead, Utica...........
Chicago Fertilizer Co., Chicago, Ill..	Bone, Blood and Potash........	Lewis Stead, Utica...........
Cleveland Dryer Co., Cleveland, Ohio..............................	Ohio Seed Maker...............	E. W. Spencer, Petersburg...
Cleveland Dryer Co., Cleveland, Ohio..............................	Horsehead Phosphate..........	E. W. Spencer, Petersburg...
Cleveland Dryer Co., Cleveland, Ohio..............................	XXX Phosphate................	E. W. Spencer, Petersburg...
Cleveland Dryer Co., Cleveland, Ohio..............................	Phospho Bone..................	E. W. Spencer, Petersburg...
Crocker Fertilizer Co., Buffalo, N. Y.	Dissolved Bone and Potash....	Manufacturer................
Crocker Fertilizer Co., Buffalo, N. Y.	General Crop Phosphate.......	John Strong & Son, Dundee.
Crocker Fertilizer Co., Buffalo, N. Y.	Universal Grain Grower........	W. H. Harvey, Utica.........
Crocker Fertilizer Co., Buffalo, N. Y.	New Rival Ammoniated Superphosphate............	Manufacturer................
Crocker Fertilizer Co., Buffalo, N. Y.	Ammoniated Wheat and Corn Phosphate..................	Manufacturer................
Crocker Fertilizer Co., Buffalo, N. Y.	Potato, Hop and Tobacco Phosphate..................	W. H. Harvey, Utica.........
Detroit Sanitary Works, Detroit, Mich..............................	Clover Leaf....................	John Martin, Ida..............
Detroit Sanitary Works, Detroit, Mich..............................	Superior Potato Fertilizer......	William Greene, Wayne......
Farmers' Union Fertilizer Co., Buffalo, N. Y.........................	Standard Phosphate............	J. M. Preston, Washington, Mich......................
Farmers' Union Fertilizer Co., Buffalo, N. Y.........................	Dissolved Bone and Potash....	Manufacturer................

expressed in parts in a hundred.—CONTINUED.

	Available nitrogen. Estimated as ammonia.	Phosphoric acid. Available.	Phosphoric acid. Insoluble.	Phosphoric acid. Total.	Potash soluble in water, estimated as K_2O.
Claimed	....	11—12	1—2	12—14	....
Found	....	14.54	.91	15.45	....
Claimed	3 —5	8—10	1—2	9—12	4—6
Found	2.69	9.75	1.09	10.84	4.83
Claimed	1 —2½	8—11	1—2	9—13	1—2
Found	1.22	9.24	1.59	10.83	2.26
Claimed	1½ —2½	9—12	1—2	10—14	2—4
Found	2.83	9.95	.99	10.94	4.59
Claimed	2 —3	10—12	....	....	....
Found	1.98	9.55	3.02	12.57	....
Claimed	....	10—12	....	12—14	....
Found	....	10.54	3.90	14.44	....
Claimed	....	14—16	2—3	16—19	....
Found	....	12.79	2.85	15.64	....
Claimed	1 —2	10—12	....	....	1—1½
Found	.96	10.78	3.34	14.12	1.09
Claimed	....	10—12	1—2	11—14	2—3
Found	....	10.91	1.45	12.36	2.06
Claimed	1 —2	7— 9	1—2	8—11	1—2
Found	1.41	7.25	1.63	8.88	1.34
Claimed	1 —2	8—10	1—2	9—12	2—3
Found	1.03	9.04	.73	9.77	2.81
Claimed	1½ —2½	9—11	1—2	10—13	2—3
Found	1.96	10.15	2.55	12.80	2.24
Claimed	2½ —3½	8—10	1—2	9—12	1½—2½
Found	2.81	8.86	3.10	11.96	2.20
Claimed	2½ —3½	8—10	1—2	9—12	3—4
Found	3.02	8.96	.78	9.74	2.68
Claimed	3.34—4.25	7— 9	1—2	8—11	3—4
Found	2.73	10.01	1.42	11.43	4.62
Claimed	4.25—5.46	6— 8	1—2	7—10	4½—5½
Found	4.32	7.66	1.34	9.00	4.59
Claimed	1½ —2½	9—11	1—2	10—13	2—3
Found	1.60	8.20	1.57	9.77	2.76
Claimed	....	10—12	1—2	11—14	2—3
Found	....	10.69	1.60	12.29	2.10

Results of analysis of commercial fertilizers for 1900,

Manufacturer.	Trade name.	Dealer and locality.
Farmers' Union Fertilizer Co., Buffalo, N. Y.	Club and Grange Formula	J. C. Baumgartner, Fraser
Farmers' Union Fertilizer Co., Buffalo, N. Y.	Potato, Tobacco and Truck Manure	Manufacturer
Grand Rapids Glue Co., Grand Rapids	G. R.	Perkins & Hess, Grand Rapids
Hardy Packing Co., Chicago, Ill.	Wheat Grower	Cane & Bartholomew, Reading
Hardy Packing Co., Chicago, Ill.	Crop Producer	J. W. Christy, Dundee
Jarecki Chemical Co., Sandusky, O.	Lake Erie Fish Guano	Shaffer Brothers, Ida
Jarecki Chemical Co., Sandusky, O.	C. O. D. Phosphate	Shaffer Brothers, Ida
Jarecki Chemical Co., Sandusky, O.	Number One Fish Guano	E. A. Goldsmith, Wayne
Michigan Carbon Works, Detroit	Homestead Potato and Tobacco Fertilizer	Collen Brothers, Hudson
Michigan Carbon Works, Detroit	Red Line Phosphate with Potash	W. H. Carey & Co., Bad Axe.
Michigan Carbon Works, Detroit	Red Line Crop Grower	Richmond Elevator Co., Lenox
Michigan Carbon Works, Detroit	Homestead Sugar Beet Fertilizer	Farmers' Co-operative Beet Sugar Co., Dundee
Michigan Carbon Works, Detroit	Homestead. A Bone Black Fertilizer	S. C. Hough & Son, Plymouth.
Michigan Carbon Works, Detroit	Red Line Complete Manure	J. H. St. John & Co., Utica
Michigan Carbon Works, Detroit	Red Line Phosphate	T. Gimbert, Adrian
Michigan Carbon Works, Detroit	Dessicated Bone	George Hancock & Son, Grand Haven
Niagara Fertilizer Co., Buffalo, N. Y.	Dissolved Bone and Potash	Burlingame & Browning, Reading
Niagara Fertilizer Co., Buffalo, N. Y.	Grain and Grass Grower	Spohr & Moore, Dundee

expressed in parts in a hundred.—CONTINUED.

	Available nitrogen. Estimated as ammonia.	Phosphoric acid. Available.	Phosphoric acid. Insoluble.	Phosphoric acid. Total.	Potash soluble in water, estimated as K_2O.
Claimed	1—2	7—9	1—2	8—11	1—2
Found	1.65	8.84	.67	9.51	1.64
Claimed	2½—3½	8—10	1—2	9—12	3—4
Found	2.80	8.47	3.25	11.72	3.30
Claimed	4.67	8.75	.82	9.57	.45
Found	4.85	6.59	3.30	9.89	None.
Claimed	½—2½	8—10	1—2	9—12	2½—3½
Found	.48	8.06	2.23	10.29	2.63
Claimed	1—3	8—10	1—2	9—12	1—1¾
Found	.90	7.75	2.16	9.91	1.39
Claimed	2—3	10—11	1—2	11—13	1—2
Found	1.87	12.31	1.91	14.22	2.00
Claimed	....	14—15	1—2	15—17	....
Found	....	14.93	1.52	16.45	....
Claimed	1—2	10—11	1—2	11—13	1—2
Found	1.20	9.64	3.08	12.82	1.58
Claimed	2½—3½	8—11	....	8—11	3—4
Found	2.52	9.92	1.18	11.10	3.01
Claimed	....	10—12	....	10—12	2—3
Found	....	12.25	1.02	13.27	1.49
Claimed	2—3	8—10	....	8—10	2—3
Found	2.18	8.14	1.10	9.24	2.88
Claimed	2½—3½	8—11	....	8—11	3—4
Found	2.86	9.31	1.16	10.47	2.67
Claimed	2½—3½	8—11	....	8—11	1½—2½
Found	2.28	10.09	.29	10.38	1.51
Claimed	1—2	7—10	....	7—10	1—2
Found	1.49	6.89	1.24	8.13	1.29
Claimed	....	14—16	....	14—16	....
Found	....	14.12	1.59	16.01	....
Claimed	1½—2½	....	25—30	25—30	....
Found	1.55	17.76	12.54	30.30	....
Claimed	....	10—12	1—2	11—14	2—3
Found	....	10.84	1.37	12.21	2.57
Claimed	1—2	7—9	1—2	8—11	1—2
Found	1.05	7.57	2.01	9.61	1.29

Results of analysis of commercial fertilizers for 1900,

Manufacturer.	Trade name.	Dealer and locality.
Niagara Fertilizer Co., Buffalo, N. Y.	Wheat and Corn Producer	Spohr & Moore, Dundee
Niagara Fertilizer Co., Buffalo, N. Y.	Potato, Tobacco and Hop Fertilizer	John Miller, Palmyra
Niagara Fertilizer Co., Buffalo, N. Y.	Niagara Triumph	Manufacturer
Northwestern Fertilizer Co., Chicago, Ill.	Acidulated Bone and Potash	J. E. Snell, Ida
Northwestern Fertilizer Co., Chicago, Ill.	Pure Ground Bone	C. C. Van Doren, Adrian
Northwestern Fertilizer Co., Chicago, Ill.	Quick Acting Phosphate	Thomas Richardson, Ubly
Northwestern Fertilizer Co., Chicago, Ill.	Raw Bone and Superphosphate Mixture	C. C. Van Doren, Adrian
Northwestern Fertilizer Co., Chicago, Ill.	Corn and Wheat Grower	C. E. Mudge, Caro
Northwestern Fertilizer Co., Chicago, Ill.	Potato Grower	S. Treat & Son, Coldwater
Northwestern Fertilizer Co., Chicago, Ill.	Garden City Superphosphate	C. E. Mudge, Caro
Northwestern Fertilizer Co., Chicago, Ill.	Acidulated Bone	J. E. Snell, Ida
Ohio Farmers' Fertilizer Co., Columbus, Ohio	General Crop Fish Guano	St. Clair County Hay Co., Smith's Creek
Ohio Farmers' Fertilizer Co., Columbus, Ohio	Ammoniated Bone and Potash	Geo. L. Mosher & Co., West Bay City
Ohio Farmers' Fertilizer Co., Columbus, Ohio	Sugar Maker, No. 1	Geo. L. Mosher & Co., West Bay City
Ohio Farmers' Fertilizer Co., Columbus, Ohio	Corn, Oats and Wheat, Fish Guano	St. Clair County Hay Co., Smith's Creek
Speidel & Schwartz, Grand Haven, Mich.	Celery Hustler	Speidel & Schwartz, Grand Haven
Swift & Co., Chicago, Ill.	Ammonia, Bone and Potash	Marshall Bros., Imlay City
Swift & Co., Chicago, Ill.	Bone Meal	Patterson & Lovejoy, Lenox.

expressed in parts in a hundred.—CONTINUED.

	Available nitrogen. Estimated as ammonia.	Phosphoric acid. Available.	Phosphoric acid. Insoluble.	Phosphoric acid. Total.	Potash soluble in water, estimated as K_2O.
Claimed	1½—2½	9—11	1—2	10—13	2—3
Found	1.65	9.74	1.77	11.51	2.31
Claimed	2½—3½	8—10	1—2	9—12	3—4
Found	2.55	9.05	.81	9.86	2.28
Claimed	3—4	9—11	1—2	10—13	2—3
Found	3.16	10.05	3.76	13.81	2.90
Claimed	1—2	10—12	2—3	12—15	1—1½
Found	1.58	13.61	2.48	16.09	1.46
Claimed	3—4	....	....	20—22	....
Found	4.80	7.49	15.27	22.76	....
Claimed	....	10—12	2—3	12—15	....
Found	....	10.17	1.29	11.46	....
Claimed	3—3½	7—9	6—8	13—17	½—1
Found	3.79	10.01	5.32	15.33	.82
Claimed	2—3	8—10	2—3	10—12	2—2½
Found	2.29	8.19	1.60	9.79	1.81
Claimed	3—4	9—10	2—3	11—13	2—3
Found	3.51	9.49	1.66	11.15	2.51
Claimed	2½—3½	8—10	2—3	10—13	1½—2
Found	2.66	9.16	1.08	10.24	1.18
Claimed	1—2	10—12	2—3	12—15	....
Found	1.61	11.91	2.50	14.41	....
Claimed	1—2	8—10	1—2	9—12	1—2
Found	1.00	6.94	2.38	9.32	2.06
Claimed	1—2	8—10	1—2	9—12	4—6
Found	1.08	7.49	2.76	10.19	4.37
Claimed	2.90—4.11	8—10	1—2	9—12	4—5
Found	2.14	9.56	1.69	11.25	3.06
Claimed	1.5—2.7	9—10	1—2	10—12	2—3
Found	1.65	8.43	1.61	10.04	2.15
Claimed	7—8	3.17—3.40	.69—1.41	3.86—4.81	1.25—2.38
Found	7.76	1.92	.63	2.55	1.62
Claimed	2.12—3.04	8—10	3—5	11—15	2—3
Found	2.15	10.54	5.15	15.69	2.20
Claimed	3.04—3.93	8—10	17—17½	25—27½	....
Found	3.49	12.46	13.59	26.05	....

Results of analysis of commercial fertilizers for 1900,

Manufacturer.	Trade name.	Dealer and locality.
Swift & Co., Chicago, Ill.	Superphosphate	J. Brooks & Son, Owosso
Swift & Co., Chicago, Ill.	Acid Phosphate	Manufacturer
Swift & Co., Chicago, Ill.	Complete Fertilizer	C. E. & M. B. Covell, Whitehall
Swift & Co., Chicago, Ill.	Sugar Beet Grower	Griggs Brothers, Rochester
Swift & Co., Chicago, Ill.	Potato and Tobacco Grower	J. Brooks & Son, Owosso
Swift & Co., Chicago, Ill.	Vegetable Grower	J. Brooks & Son, Owosso
Swift & Co., Chicago, Ill.	Ammoniated Bone and Potash	Manufacturer
Swift & Co., Chicago, Ill.	Raw Bone Meal	J. Brooks & Son, Owosso
Williams & Clark Fertilizer Co., Cleveland, Ohio	Acorn Brand Acid Phosphate	Manufacturer
Williams & Clark Fertilizer Co., Cleveland, Ohio	Royal Bone Phosphate	H. J. Willert, Almont
Williams & Clark Fertilizer Co., Cleveland, Ohio	Prolific Crop Producer	W. F. Overmeyer, Ray
Williams & Clark Fertilizer Co., Cleveland, Ohio	Dissolved Bone and Potash	W. F. Overmeyer, Ray

…expressed in parts in a hundred.—CONCLUDED.

	Available nitrogen. Estimated as ammonia.	Phosphoric acid. Available.	Insoluble.	Total.	Potash soluble in water, estimated as K_2O.
Claimed	3.64—3.93	8—10	4— 8	12—18	2— 3
Found	3.14	7.75	5.96	13.71	3.43
Claimed	....	16—18	1— 2	17—20	....
Found	....	17.90	1.13	19.03	....
Claimed	1.21—2.12	8—10	3— 5	11—15	1— 2
Found	1.35	7.14	6.49	13.63	1.10
Claimed	3.04—3.93	8—10	3— 5	11—15	5— 6
Found	3.26	9.52	.63	10.15	5.81
Claimed	3.93—4.84	10—12	1— 3	11—15	5— 6
Found	4.28	7.37	1.01	8.38	7.84
Claimed	3.93—4.84	9—11	1— 3	10—14	10—11
Found	4.40	8.91	1.19	10.10	8.88
Claimed	5.75—6.96	....	16—17	16—17	3— 4
Found	5.99	....	16.43	16.43	3.41
Claimed	4.55—5.46	....	....	23—27½	....
Found	4.92	9.61	14.41	24.02	....
Claimed	....	11—12	1— 2	12—14	....
Found	....	14.40	1.24	15.64	....
Claimed	1.21—2.42	5— 6	2— 3	7— 9	2— 3
Found	1.09	8.25	.79	9.04	2.75
Claimed	1 —2	5— 6	1— 2	6— 8	1— 2
Found	1.65	7.28	2.92	10.20	1.16
Claimed	....	6— 7	1— 2	7— 9	2— 3
Found	....	9.63	2.12	11.75	2.17

REPORT OF THE DEPARTMENT OF MATHEMATICS AND CIVIL ENGINEERING.

To the President:

SIR—This year's record is one of hard work, and, I think, of considerable efficiency as well. If results have not been at all times as satisfactory as could be wished, it is not due to lack of effort, but probably to the unusual number of students and classes we have met, and to the difficulties experienced in providing teachers for them.

At the close of the spring term of 1899, Instructor F. V. Warren resigned his position with us to take charge of a department of mathematics in another college. The vacancy thus caused was not filled by the appointment of a regular successor, so that our permanent teaching force has comprised only three members. Additional help was provided by the temporary engagement of students of this College. In the fall term, Mr. A. Knechtel, a senior student, took charge of two sections in algebra for the whole term and of a third section in the same subject for the last half term. In the winter term, Mr. Knechtel taught one section in geometry, and Mr. F. Williams, a post-graduate student, taught a section in algebra. During the spring term, Mr. Williams taught five classes in geometry.

The following text-books have been used in our classes during the year: Beman & Smith's Higher Arithmetic by the class in mensuration; Evans' Algebra by the women and agricultural students; Hall & Knight's College Algebra (Sevenoak's revision) by mechanical students; Wentworth's Geometry; Anderegg & Roe's Trigonometry by the fall term class; Jones' Trigonometry by the spring term class; Tanner & Allen's Analytic Geometry; Taylor's Calculus; Hodgman's Surveying; Johnson's Surveying for all classes in civil engineering; Church's Mechanics; Merriman & Jacoby's Graphic Statics.

We have given 93 special examinations during the year, some of which were for admission to advanced standing and some to make up back work.

The assignments of our teachers to class work, the number of students enrolled, etc., are shown by the tabulation presented below. In the two cases in which the names of two teachers are bracketed opposite a single subject, a transfer of the classes was made at mid-term from the first to the last named teacher. It is proper to add that Prof. Babcock and Mr. Beal assisted me in the surveying field work in the fall and spring terms.

Class work of the department of mathematics and civil engineering for the college year 1899–1900.

Class.	Subject.	Teacher.	Class-room.	Hour of meeting.	No. hours per week.	No. students in class.
FALL TERM:						
Freshmen	5 year algebra	Prof. Babcock	B, College Hall	10-11	5	43
"	M. algebra	" "	B, " "	8-9	5	28
"	M. "	" "	B, " "	11-12	5	27
"	M. "	Mr. Beal	C, " "	8-9	5	29
"	M. "	" "	C, " "	11-12	5	25
"	Ag. "	" Knechtel	Ag. Laboratory	8-9	5	34
"	Ag. "	" "	Hort. Laboratory	11-12	5	31
"	Ag. "	" Beal & Mr. Knechtel	C, Col. Hall & Ag. Lab.	9-10	5	35
Sophomores	Ag. geometry	" "	C, College Hall	10-11	5	30
"	Ag. "	" " & Prof. Babcock	B & C, College Hall	9-10	5	31
"	M. trigonometry	Prof. Vedder	Engineering	8-9	5	32
"	M. "	" "	"	10-11	5	26
Juniors	Int. calculus	" Babcock	B, College Hall	4-5	5	27
"	Surveying (class)	" Vedder	Engineering	11-12	2	31
"	" (field)	" "		1-3	2	16
"	" "	" "		1-3	2	15
Seniors	Ag. civ eng. (class)	" "	Engineering	4-5	5	5
"	" " " field	" "		1-3:30	$2\frac{1}{2}$	5
"	Graphic statics	" "	Engineering	9-10	3	11
Totals	19 sections				$81\frac{1}{2}$	481
WINTER TERM:						
Freshmen	5 year algebra	Prof. Babcock	B, College Hall	9-10	5	32
"	M. algebra	" "	B, " "	10-11	5	26
"	M. "	" Vedder	Engineering	10-11	5	28
"	M. "	Mr. Beal	C, College Hall	10-11	5	28
"	M. "	" Williams	Mechanical Laboratory	10-11	5	21
"	Ag. "	" Beal	C, College Hall	8-9	5	19
"	Ag. "	" "	C, " "	9-10	5	25
"	Ag. "	" "	C, " "	1-2	5	23
"	Ag. "	Prof. Babcock	B, " "	1-2	5	29
"	M. geometry	Mr. Beal	C, " "	11-12	5	25
"	M. "	" Knechtel	Engineering	11-12	5	19
"	M. "	Prof. Babcock	B, College Hall	11-12	5	25
Sophomores	Anal. geometry	" "	B, " "	8-9	5	26
"	" "	" Vedder	Engineering	9-10	5	22
Juniors	Mechanics, eng'g	" "	"	8-9	5	22
Totals	15 sections				75	370
SPRING TERM:						
Freshmen	Mensuration	Prof Babcock	B, College Hall	10-11	5	24
"	5 year geometry	Mr. Williams	C, " "	11-12	5	27
"	M. geometry	" "	Mechanical Laboratory	10-11	3	16
"	M. "	" Beal	B, College Hall	11-12	3	21
"	M. "	Prof. Babcock	B, " "	11-12	3	12
"	M. "	" "	B, " "	9-10	3	13
"	Ag. "	Mr. Beal	C, " "	8-9	5	20
"	Ag. "	" "	C, " "	9-10	5	17
"	Ag. "	" Williams	Ag. Laboratory	9-10	5	20
"	Ag. "	" "	" "	8-9	5	16
Sophomores	W. "	" "	B, College Hall	4-5	5	11
"	Ag. plane trig	Prof. Vedder	Engineering	8-9	3	22
"	Ag. " "	" "	"	10-11	3	18
"	Ag. surv'g (class)	" "	"	8-9	2	23
"	Ag. " "	" "	"	10-11	2	21
"	Ag. " (field)	" "		1-3	2	23
"	Ag. " "	" "		1-3	2	21
"	Dif. calculus	" Babcock	B, College Hall	8-9	5	23
"	Dif. "	Mr. Beal	C, " "	10-11	5	23
Juniors	Mechanics	Prof. Vedder	Engineering	11-12	5	19
Seniors	Civ. eng'g class	" "	"	9-10	5	16
"	" " (field)	" "		1-3	2	16
Totals	22 sections				83	425
Grand totals	56 sections				$239\frac{1}{2}$	1,276

Besides a few good tapes, not much has been added to our instrumental equipment. A needed improvement in record keeping has been provided in the purchase of two filing cases with cards for the same. The total expenditure for the department for these items and all needed supplies has been $180.90. The inventory of department property, including instrumental equipment, observatory, office, and class-room furniture, shows an aggregate value on June 30 of $4,065.52, against $4,039.93 for last year.

A sewer sub-main was planned and staked out by the department, to provide for wastes from the library, the new women's building and the row of laboratories on the east of the campus. Minor changes in pipe lines, when brought to our notice, have been recorded. Beyond these items, the teachers of the department have had little time for practical engineering.

Respectfully submitted,

H. K. VEDDER,

Professor of Mathematics and Civil Engineering.

AGRICULTURAL COLLEGE, MICH.,
June 30, 1900.

THE LIVE STOCK INDUSTRY IN MICHIGAN, 1900.

MICHIGAN LIVE STOCK; REVIEW OF ITS PRESENT CONDITION.

ROBERT GIBBONS, EDITOR MICHIGAN FARMER.

In reviewing the present condition of the live stock interests of the State, it will not be considered out of place if something is said regarding its prime importance to the material interests of its farmers as well as the future value of the farms. Improved live stock is a certain indication of improved farming and enterprising farmers. No farmer can long take an interest in the improvement of his stock without becoming more intelligent and a better farmer. Good farming, he will soon discover, is an essential to success with improved stock. To improve live stock good feeding is just as important as good breeding. This means care on the part of the farmer to produce, during the growing season, ample supplies of grain and forage to carry his stock through the winter months, and to maintain them in good condition.

In studying out the requirements of his stock, the proper care, feeding and breeding, the farmer insensibly broadens out, and acquires a fund of information that can only be acquired by practical contact with these problems. His knowledge of business methods is also increased, because he is constantly buying and selling, and his association with business educates him in the minutia of business transactions. It will be found in every farming community that the most enterprising and intelligent are interested in the improvement of some branch of live stock, either as breeders or as growers for market purposes.

The stock breeder as a rule is a benefactor to the community in which he lives, for through his work the live stock in the neighborhood is improved and rendered more valuable in every way. It is true he does not always reap a fitting reward for his labors. In fact he is seldom benefited financially to the extent those are who avail themselves of his skill and enterprise. The general farmer usually profits more from the improved herds and flocks kept in his neighborhood than do those who own them. The live stock of a whole section may be improved to the extent of thousands of dollars, yet the breeder who made the improvement possible lose money in the business. Breeders are frequently compelled to sell their surplus at less than the net cost, and yet so fascinating is the business that many remain in it year after year, doing an immense amount of good, but nearly always at a loss. We cannot forbear making due acknowledgement to such men for their

enterprise and public spirit, which ought to be more generously rewarded.

Michigan, from its position, soil and climate, should be the home of the breeder of improved stock. Its grain and forage crops should never be fed to scrubs. Its flocks and herds should be maintained at such a high standard as to win national recognition, and make it the reliance of those who are seeking after the best. In every way possible the breeder should be encouraged to continue his beneficent work. The State and country fairs should recognize in a more generous manner the good such men are doing for the community and the State. and his neighbors accord him due credit for what he has accomplished. He furnishes the best machine to turn the farmers' coarse grains, forage and by-products into a more marketable and valuable commodity, and the farm that is producing meats, and wool, and dairy products, is each year increasing in fertility and ability to grow crops. Good live stock must always be the basis of successful farming in the Peninsular State.

HORSES.

The breeding and raising of horses in Michigan traces back to the earliest period of settlement by civilized people, and has continued an important factor in its agricultural development to the present time. The early French settlers, coming from Lower Canada and direct from France, brought with them horses representative of those countries, so that the Canadian French pony and the horses used in the French army were the foundation stock relied upon by the early French settlers. These were more or less modified by intermixture with the Indian pony, which was numerous throughout the country surrounding the Great Lakes. The most important of these breeds were the Canadian French ponies, a hardy race resembling diminutive Percherons, from which breed they were undoubtedly descended. Their characteristics were heavy flowing manes and tails, small heads, bold prominent eyes, short heavy necks, broad chested, deep bodied, compactly built, with broad and frequently sloping rumps, and standing on short, well formed legs, with splendid bone and excellent feet. They had a short trappy gait at the trot, with rather exaggerated knee action, and were very hardy and enduring. The French settlers were continually testing their speed at the trot against each other. Racing on the ice during the season was one of the great diversions of the French settlers, and the champion on the ice had as much honor paid him as the champion of the modern track. With the advent of the British into the State came the English Thoroughbred, and later came the American bred horse of composite character. With the final ending of the wars between France, Great Britain and the United States, the emigration of Americans from New York and the New England States set in, and as these immigrants came with the intention of building homes for themselves, and clearing up the wilderness and fitting it for cultivation, they brought their cattle and horses with them. These of course represented the sections from which they had emigrated, and were generally of Thoroughbred and Morgan blood. The latter came largely from the New England States, while horses with Messenger and other Thoroughbred blood, came mostly from New York. There was also a good deal of Bashaw blood, which traced back to imported Grand Bashaw, an

Arabian whose color and conformation can yet be traced in some of his descendants. But the large number of horses brought in during the time when the tide of eastern emigration set strongest toward Michigan, had more or less Thoroughbred or Morgan blood. As the country became settled up, and the interest in its horse stock increased with the wealth of its people, a good many finely bred horses were imported into the State. Some were brought in for racing purposes, but were afterwards used in the stud; others were brought in for breeding purposes, and used wholly for that purpose. There were Thoroughbreds from Kentucky and Tennessee, already noted for the quality of their horses, pacers from the Canadian provinces whose early origin is wrapped in obscurity, and roadsters and trotting horses from the eastern states, where speed at the trotting gait was being cultivated. This was the condition of affairs in the late forties and early fifties.

The improvement of the horse stock of the State in a systematic manner really began soon after the State Agricultural Society began to hold its annual fairs. The exhibits of horses were always great features and the competition between breeders and stallion owners became so sharp as frequently to lead to bitter controversies between the various competitors. In these controversies we notice two facts which show conclusively that the question of breeding was proceeding along practical lines. These were the stress put upon the lines of blood represented in the various animals, and the performance of themselves or their ancestors. Breeding and performance are still, and must always be, the great reliance of the breeder who is aiming to improve his stock.

The competition noted above soon began to attract the attention of many of the well-to-do farmers and business men of the State, and many of them became so interested that they embarked in the business themselves. This was so to a large extent at Detroit, Jackson, Pontiac, Coldwater, Ann Arbor, Flint, Kalamazoo, and other points, and the country tributary to those points are still noted for their horse stock. Importations from the East and Kentucky continued to be made, the former consisting of animals noted for their trotting ability, the latter Thoroughbreds. Tracks and courses were established all through the older counties, and no doubt did much to promote an interest in horses and to encourage their improvement. The results can be traced in the reputation which Michigan bred horses began to get in other States for their hardiness, beauty and general utility. Eastern dealers began to visit the State for roadster and driving horses, and carriage teams. The only point in which they were generally faulted was a lack of size, but their upstanding style and breedy looks compensated in a large measure for this defect.

This was the condition of affairs when the civil war broke out. It was then seen what a grand work those men who had labored to improve the horse stock of the State had done for the country and the government. Michigan supplied thousands of horses for the cavalry and to horse the artillery of the finest quality. No other horses were so generally sought for and more thoroughly proved their adaptability for army purposes. From the early battles in Virginia to Sheridan's campaigns in the Shenandoah Valley, and the final struggles at Five Forks and Appomattox, Michigan men and Michigan horses were factors in nearly every campaign and battle. But the result was to practically

sweep away nearly all that had been accomplished, and the breeder had to utilize the fragments and start afresh in the work of improvement. There was, it is true, an excellent starting point in the numerous brood mares that were yet on the farms of the State, and as the people were generally prosperous, the work of improvement was rapid. The Hambletonians, as those horses with the blood of Hambletonian 10 were called, were brought into all the older counties, and when bred upon mares of Morgan, Thoroughbred, Bashaw and Clay blood, gave a splendid class of hard-bottomed roadster and driving horses, which were always in request. Horses with the blood of Mambrino Chief were brought in, and this strain was found to mix kindly with the Hambletonian, which came from the same fountain head.

The great devlopment of the lumber business also led the farmers in the counties near the Saginaw Valley to engage in breeding the heavy draft horse, of which but few had been raised in the State previous to 1860. The Clydesdale was the first breed to which much attention was paid, and he held his position for some years, importations of breeding stock being made from Scotland and Canada. Later the Percheron was introduced and received with much favor. A few Suffolk Punch horses were brought in, but though highly spoken of by the few who tried them, did not prove popular. The English Shire, a near relative of the Clydesdale, was also brought in, and is popular with those who desire a very heavy draft horse.

The Cleveland Bay, an old English breed, was for some time very popular in the State as a breed to cross with trotting-bred stock to give more size. But their lack of style and action, due no doubt to many of the animals imported lacking breeding, has caused them to be entirely eliminated. The French Coacher, a horse of commanding appearance, and good action, with a large amount of Thoroughbred blood, is the most popular at present with breeders, outside of the American Trotter.

The great depression in the value of horses a few years ago did much injury to the breeding interests of the State, and led to the virtual abandonment of a majority of the stock farms on which draft horses were bred. Since the improvement in values has again brought horse breeding into prominence, the Percheron has taken the lead among the draft breeds, the Clydesdale and Shire being neglected, so that those who wish horses of those breeds now depend upon the Canadian provinces for what they require. The Percheron is naturally a lighter animal than the two breeds named, is more active, a better traveler, and has a disposition which makes him very popular on the farms of the State. It is altogether probable, from a study of this breed and its capabilities, that it is destined to remain in its present advantageous position in Michigan, although the men who do the heavy trucking in the large cities, especially around railways, generally prefer animals of Shire or Clydesdale blood.

In light harness horses the favorite breeds at present are the American Trotter and the French and German Coach horses. A few Hackneys have been tried, but have not met with much favor. In comparison with all other breeds, the American trotting-bred horse is far and away the most popular. He is regarded as the most useful, as he can be utilized in every capacity except as a heavy draft. On the farm, on the road, in the carriage, or on the track, he does equally well. He has

style, action, vigor, hardiness, and commands better prices than any other animal that can be bred on the farms of the State. In fact he is an American product, bred for Americans and therefore best suited for their wants and requirements. He is also the horse that foreign countries will take more of and pay more for than any other. The demand for him must grow from year to year, as a knowledge of his good qualities becomes known abroad. No other breed can ever take his place on this continent. The bred has its faults, and some years ago they were serious ones. The drop in values did much to give breeders a truer opinion of what was wanted in a good horse, and eliminated those animals whose only value was their speed. The majority of them had neither beauty, style or size, frequently had ill-formed hind legs with curby hocks, loosely coupled, and were lacking in substance. But the size has been increased, the angular forms have been rounded out, their legs and feet are excellent, and they have acquired much in beauty and style. A finished standard-bred trotting horse is today as handsome an animal as stands on iron, and when it comes to a question of utility he is in a class by himself.

Breeding in this State must be conducted hereafter along lines that will give high class horses. Common horses can be raised so cheaply on the range that Michigan farmers cannot afford to compete with the west in their production. The draft types should be maintained in their purity, whether Percheron, Clyde or Shire, and with them weight and soundness are the great desideratums. This means good care, generous feeding, and holding them on the farm until at least four years old. This class of horses will always be wanted in the big cities of the United States, as well as in Great Britain and on the continent of Europe, and raising them promises to remain a remunerative business, especially as they cost much less to breed and develop than high-class carriage, roadster, or track horse.

CATTLE.

The cattle business in Michigan has been in a state of transition for the past three years, during which rapid changes have been made in the breeding of the cattle on many farms. Some years ago Michigan was esentially a beef-raising State, with dairying a secondary consideration, and the dairyman generally relying upon selected animals of the beef breeds for his purposes. When the west and southwest began sending beef cattle by the thousands to market, and selling them at prices which made the business of raising beef on the high-priced, cultivated farms of this and other States unprofitable, there was a general movement started to change from beef-making to dairying. The standard beef breeds, which at that time were represented in the State by numerous grade herds of the highest quality, were gradually sold out and found their way to the butcher, or were crossed with bulls of the dairy breeds, until but few farms in the State, outside of those whose owners had pure bred herds, could show any good beef animals. At the time the change began, besides the large number of grade herds, there were numerous herds of Shorthorns, Herefords, Galloways and Devons owned in the State, the breeds standing in the order named as to numbers. At a State fair held in the early eighties we counted thirteen herds of Shorthorns, eight of Herefords, four of Galloways and

four of Devons on exhibition, besides numerous entries by those who could not show in the herd classes. These were all owned in Michigan, and there were many others in the State which were not represented. These fine herds, which had cost a great deal in hard cash, and more in time and labor, to build up, were largely broken up, and when, through changes in requirements of our own people, and the enlarging demand from other countries for American cattle and dressed beef, the business of the feeder once more became a remunerative branch of farming, it was difficult for farmers to secure well bred sires for use on their grade cows. Besides this, the herds of cows on most farms had been crossed with bulls of the dairy breeds until they were generally mongrelized, and possessed of no characteristics which suited the man who wanted good beef-making cattle. The condition of Michigan's cattle stock could be pretty accurately gauged by a study of the Eastern markets, to which they were generally shipped, as they actually stood at the bottom of the list. So long as beef-making was an unprofitable business, this did not matter much, but for the past three years it has cut off thousands of dollars from the incomes of farmers who were feeding a certain number of cattle every year. To get feeders of any quality they had to rely upon the Chicago market, to which the west was sending in thousands of very fair cattle, but in thin flesh. The best lots of cattle sent to market from this State have generally been from these western stockers. This year some really choice cattle have been sent in to the Detroit and Buffalo markets, which were bred and fed within the State, and which sold near the extreme top of the market. They were the first arrivals of what will soon be a regular supply of high-class cattle from the farms of this State. At present the breeds favored by those who make a business of feeding cattle, are the Shorthorn, the Hereford and the Galloways, with the first named far in the lead in numbers. This, we think, comes from two causes: the former popularity and wide acquaintance with Shorthorns for the thirty years ending with 1890, during which time nearly all the improved cattle on the farms of the State carried more or less blood of the Shorthorn. The other reason is that the milking quality was quite a pronounced feature in the earlier Shorthorns brought into the State, which gave them a high value with those farmers who were more or less interested in dairying as a side issue. No one can truthfully dispute the ability of the Hereford or the Scotch Polled breeds to grow beef cheaply and of the highest quality. Their record in the western states and on the range prove this beyond question. But the fact remains, that even when fine herds of these breeds were owned in Michigan, their owners had to depend upon the west and those who wished to start pure bred herds, for an outlet for their surplus. The average farmer clung to the Shorthorn. In the renaissance of beef production in the State the Shorthorn is meeting with the most favor, with the Red Polls, Herefords and Galloways standing in the order named.

So much for the beef breeds. In what condition are the dairy herds? From a practical standpoint the dairy herds on Michigan farms are really in better shape than ever before. It is true there is not as active a demand for pure bred animals of the dairy breeds as when everyone was anxious to change from beef-making to dairying; but most farmers who make dairying a leading feature in their business are satisfied that

it is safer to rely upon them than upon breeds whose milking qualities have never been developed, or allowed to decline through neglect. The leading breeds are the Jerseys and Holsteins, with some Guernseys and a few Ayrshires. The Red Polls are also being utilized in the dairy to some extent. The average farmer who is making butter generally prefers the Jersey, while the farmer who is selling milk, or furnishing it to a cheese factory or condensary, prefers the deeper-milking Holstein and its grades. The Guernsey is in many respects very similar in its characteristics to the Jersey, and its butter product is also of a high character, while it is believed to slightly excel it in quantity of milk. In quality of milk the Ayrshire is rather ahead of the Holstein, but behind it in yield. In fact the Holstein may be accepted as the deepest milker among the dairy breeds.

The observations on the qualities of the different breeds are not expected to cover individual animals, but to refer to the average of the breeds. There is, in any of the breeds referred to, a wide difference between the yields of the best and the poorest, which shows that there is still much room for improvement, and that it is not safe to rely upon an animal's pedigree alone as settling its value. Good ancestry is a grand thing in any animal, but the best ancestry will never make a worthless one valuable. The farmer must look at results, and to be certain of them continued tests, close observation and accurate records of his animals are essential.

There is one point in this connection on which many have been mistaken, and that is the use of bulls of the different breeds in building up a dairy herd. They believed it possible to secure the butter-making quality of the Jersey with the large yields of milk of the Holstein. Under this impression many have experimented on their herds until they are practically mongrelized, and their progeny is likely to be anything but what is expected. We believe it safest to select the breed found best suited to the environment and requirement of the farmer, and then use bulls of that breed until the herd is practically pure bred, eliminating unprofitable animals, and selecting the best bulls to continue the improvement. With such a herd the farmer is safe in relying upon the calves proving the equal, if not the superior, of the cows from which they are bred. Such a herd would be a money-maker under all circumstances, and the surplus females would command, as they should, double the price of the common cow. But such a herd can never be built up by the use of bulls of different breeds, whose characteristics are so widely at variance that crossing them is sure to injure the reputation of both. No one breed has a monopoly of all the good points, but it assuredly has more of them than any mongrel can possess.

The dairy herds of the State have been built up at heavy cost, and it would be very foolish to sacrifice them because beef cattle are so remunerative at present. Michigan is sure to become more and more of a dairy State, for which her soil and climate are well adapted, and if beef-making is also developed, as it should be, it means lessened competition for the dairyman. There is no doubt but that one help in sustaining the butter market the present season is the fact that beef-making is decreasing competition, and thus adding to the value of the product by lessening the supply. If those butter-makers who have been turning out a product that sells one-third below good butter,

and is only purchased because of its cheapness, or for the reason that a better quality is not obtainable, would send their milk product to a creamery, cheese factory or condensary, where it would be utilized in turning out products of such a quality as to command a good market, it would have the happiest effect upon the dairy interests of this State, and add very materially to the reputation of its dairy products as well as to the income of those who are now selling their butter at such low prices as to make the business unprofitable to themselves, and an injury to everyone else engaged in the business.

The effect of dairying upon the farms where it is made an important branch of the business, renders its maintenance and development an absolute essential on the older lands of the State. There is no product that takes so little from the soil compared with its value as a pound of butter. The fertility sold with it is so infinitesimal as not to be appreciable; hence dairying must be regarded as one of the very best means of restoring fertility to worn out soils while returning a fair and increasing income to their owners. Dairying conducted in accordance with sound business principles offers to the enterprising farmer as many advantages as any branch of agriculture that can be named, because the income it brings is secured without loss to his land, which will steadily improve in its ability to produce crops.

HOGS.

While Michigan has never had the reputation as a producer of hogs that several of the states in the corn-belt have secured, the raising of hogs has been an important part of the business of its farmers since its admission into the Union. It is true the business has not been followed to the extreme limits that it has been in the states south and west of it, but it has generally proved remunerative to those engaged in it. The rule in this State has been to make the raising of hogs an important branch of the business of the farm, but to combine it with other branches which would aid or be aided by it. Thus the dairy farm, the fruit farm and the grain farm nearly always has its herd of hogs, which utilize to good advantage the waste and by-products which would otherwise be unproductive of revenue, and in fact become a nuisance. The hog utilizes these, turns them into a staple product, and carries them to market in a form which always commands ready cash, and for which there is a steady and increasing demand.

The condition of the industry in this State at present is very satisfactory to those engaged in it. Prices during the past year have been maintained at a high average, and while there have been losses from disease, the general outcome has been satisfactory. The tendency at present is to increase the numbers kept on the farms, as well as to improve their quality. As a rule the breeding of the hogs on the farms is better on the average than that of any other class of stock. Several improved breeds have been widely introduced, and there is hardly a farm on which the hogs do not show a more or less infusion of improved blood. There is a disposition, however, to change from one breed to another, which has done much to injure the sale of Michigan hogs, by breaking up that uniformity in appearance that is always a strong factor in securing good prices. Color has little to do with values if the lot are all of one color; but if they are the products of boars of

different breeds and colors, and show a lack of uniformity in other respects, the buyer will not pay top prices for them. With good hogs of all the improved breeds available to the farmer at very reasonable prices, and quality and uniformity being such an important factor in the market, it is only good business policy for the farmer to stick close to the breed he prefers, and breed them as closely to type as possible. The most apparent faults to be found with Michigan hogs, as shown by the criticisms of those who buy on the large markets, are lack of uniformity and finish. They are marketed before they reach the market standard, and show lack of that finish which comes from careful and generous feeding when being fitted for market. The dairy hogs are nearly always marketed before they have been finished, and have neither the weights nor quality which their breeding would make possible under better management. Then thousands of hogs from this State go to market from the pastures, and under the name of "grassers" are placed at the bottom of the list. Most of these hogs are just in the condition where a few weeks of grain feeding would add greatly to their value to the buyer, whether he is a packer or a local butcher. At present values for prime hogs, could the grain grown on the farm be put into market in a way to bring better prices for the grower than in these growthy, half-finished hogs?

Another fault is that farmers as a rule rely upon young brood sows and males as breeding animals, which has a tendency to produce smaller litters and less growthy animals. A prolific brood sow should be kept for several years, and this is also true of the male hogs if we want strong, healthy litters of growing pigs.

The breeds which are popular at present are the Poland-China, the Berkshire, the Jersey Red, the Chester White and Victoria. Breeding herds of these are quite numerous in the State, and their popularity runs in the order named. Added to these breeds there are also herds of pure bred Tamworths and Large Yorkshires, brought in to give more of what is known as the bacon type to the other breeds. It is yet too early to determine how popular these breeds will become, as so far they are nearly entirely in the hands of breeders, and have not therefore been tested by the general farmer. Their ability to produce pork cheaply and of high quality will determine their future. The Canadian, English and Danish farmers have found these hogs profitable because of the higher prices secured for their bacon as compared with the other breeds. Whether this advantage will continue when such hogs are produced by the thousands is a problem which can only be settled by actual tests. Their admirers claim the market for such bacon is practically unlimited, while others assert it is a limited one, confined to the wealthy and professional classes in the large cities of this country and Great Britain, while the working classes prefer a thicker and fatter bacon than the Tamworth and Large Yorkshire generally produces at a marketable age. There is probably some truth in the contention of each, and we believe that some farmers will find them profitable and others unprofitable, according to their markets. They will, therefore, be considered special breeds, bred and fed for a special purpose, and will not, therefore, displace other breeds only to a limited extent. The incorporation of their blood to some extent in the hogs of the corn-belt

may prove very desirable, giving them more bone and muscle and a rangier type.

Under present conditions it is good policy for farmers to keep their hogs bred up to a high standard. This is the only way to secure the largest profits from the food they consume. To good breeding must be added good feeding and a careful attention to hygiene. Michigan suffers less from diseases so fatal to hogs than other states, which we attribute to a greater variation in the food than in the corn states, and the greater hardiness of the animals themselves because not descended from stock raised largely on corn. Variety of food, clean, comfortable quarters, a good range while growing, and pure water to drink, are all conducive to health and freedom from disease. The introduction of breeding stock from states where swine plague is more general, should be done with caution, and if the precaution is taken to keep it apart from the farm herd for a time it will frequently save both trouble and loss.

So far as the outlook is concerned, the hog raiser has nothing in sight to discourage him. His business improves with activity in trade, business or war. The cured meat of the hog is the safest reliance where it has to be transferred long distances and fed to men engaged in arduous and exacting labor. Hence the lumberman, the miner, the soldier and the sailor find it best suited for maintenance in health and vigor, and it is used to equal advantage in the tropics or at the poles. So long as it maintains its position in the food supply of the great commercial nations, just so long must the business of producing it be remunerative.

The price of live hogs has been well maintained the past year, and at no time has it been so low as to be unremunerative. This will be seen upon consulting the following summary of the average price ruling during the past year in the Chicago market, the most important one in the world in fixing values. The top price each week is given, and also the average of all the sales for each week:

Week ending—	Top price.	Average price.	Week ending—	Top price.	Average price.
August 12, 1899	$4 90	$4 55	February 10, 1900	$5 10	$4 90
August 19, 1899	5 00	4 70	February 17, 1900	5 05	4 90
August 26, 1899	4 90	4 65	February 24, 1900	5 10	4 85
September 2, 1899	4 92½	4 60	March 3, 1900	4 97½	4 80
September 9, 1899	4 75	4 40	March 10, 1900	5 00	4 85
September 16, 1899	4 77½	4 50	March 17, 1900	5 20	5 00
September 23, 1899	4 80	4 55	March 24, 1900	5 25	5 05
September 30, 1899	4 90	4 60	March 31, 1900	5 52½	5 30
October 7, 1899	4 90	4 60	April 7, 1900	5 65	5 45
October 14, 1899	4 75	4 55	April 14, 1900	5 80	5 55
October 21, 1899	4 60	4 35	April 21, 1900	5 85	5 60
October 28, 1899	4 50	4 30	April 28, 1900	5 65	5 50
November 4, 1899	4 42½	4 25	May 5, 1900	5 57½	5 30
November 11, 1899	4 35	4 10	May 12, 1900	5 45	5 25
November 18, 1899	4 20	4 05	May 19, 1900	5 57½	5 35
November 25, 1899	4 10	3 95	May 26, 1900	5 35	5 25
December 2, 1899	4 02½	3 85	June 2, 1900	5 25	5 10
December 9, 1899	4 17½	3 90	June 9, 1900	5 25	5 15
December 16, 1899	4 25	4 00	June 16, 1900	5 25	5 10
December 23, 1899	4 20	4 05	June 23, 1900	5 37½	5 20
December 30, 1899	4 45	4 25	June 30, 1900	5 42½	5 25
January 6, 1900	4 60	4 40	July 7, 1900	5 50	5 30
January 13, 1900	4 75	4 50	July 14, 1900	5 55	5 35
January 20, 1900	4 80	4 60	July 21, 1900	5 40	5 20
January 27, 1900	4 90	4 60	July 28, 1900	5 45	5 30
February 3, 1900	5 00	4 75	August 4, 1900	5 50	5 30

THE PRODUCTION OF WHEAT IN MICHIGAN.

O. C. HOWE, CHIEF OF DIVISION OF STATISTICS, DEPARTMENT OF STATE.

In the diversification of her industries and resources Michigan stands first among the states of the Union. While this naturally prevents the State from being especially noted for its mining or manufacturing interests, or for the amount of its agricultural productions, yet the numerous vocations to which the people are enabled to devote their attention insure a more general and lasting prosperity for a series of years. The people who came here in the early days of the history of this State, of necessity turned their attention to agricultural pursuits. In many places the prairies were soon covered with growing grain, while in other sections the forest needed to be cleared away before the land could be devoted to the growing of crops. From that time to the present, nearly a century, agriculture has been a prominent industry in Michigan. The untiring efforts of the thousands of tillers of the soil have converted, out of an almost unbroken wilderness, thousands of farms yielding abundantly in crops and thus enriching their owners.

In 1890 the most important industries in the United States were, in their order, manufactures, agriculture, transportation, mining and fisheries. In each of these Michigan had, at that time, made a reputable progress, with a fair prospect that each would continue to develop. Since then another decade has passed and it is now the duty of every thinking, patriotic citizen to study carefully the trend affairs have taken during these years, and to ascertain correctly the situation at the present time, in order that the future may be shaped with the idea in view of conserving what has been gained and also of rebuilding where a loss has occurred.

The student of conditions in this State will find that we have made good growth along manufacturing lines; the possible exception is in the manufacture of lumber, but Michigan can never again rank first in that respect until nature has once more covered the lower peninsula with forest trees. The development of our mines still continues, and as the output of coal and the manufacture of coke increases we will be able to convert more of the iron ore into pig iron, or, better still, a finished product. We are also still increasing along commercial lines. The railway systems are constantly at work increasing the efficiency of their roads, all of which is warranted by the growth of their business, and the Great Lakes bordering on our State are floating hundreds of boats, plying back and forth with their tons of burden, materially increasing the wealth of Michigan and also furnishing employment for many of her citizens.

While it is true that we have made an advancement in almost every way, morally, intellectually and financially, still one could hardly maintain without successful contradiction that agriculture in this State had developed like the other industries and at the present time had a pleasant prospect for the future. Whether anyone is especially to

blame for this or whether it is simply one of the periods of depression that come some time or other to those engaged in any business, is a question the people should ponder over in order that they may arrive at the correct solution. The problem involves not only the determination of the causes for the present conditions, but equally as well what methods shall be adopted to make this industry, which is the most important one to our people, an occupation in which one can engage with profit.

In the past the one great money crop has been wheat. Upon the yield per acre and the price obtained for that commodity largely depended the profits in farming. Michigan farmers generally buy corn and seldom produce more oats than are consumed here. It is true that some of these grain crops have been fed to stock and then sold, yet it is fair to say that until recently the one great crop that has produced the revenue has been wheat. Thus it becomes necessary in discussing questions pertaining to agricultural depression to study the question of wheat production and the influences which affect it.

In order to be fair and just and also to arrive at a correct conclusion, it will be necessary to keep in mind several factors which apply only occasionally and separate them from others which always exist and the effect of which can always be ascertained before hand with great accuracy. In the one case the result cannot be determined in advance and advantage taken because the state of affairs is brought about by conditions over which we have no control, while on the other hand, in the other case, the reverse is true. To illustrate, in 1898 we had what was probably the largest crop of wheat ever grown in Michigan. In the start conditions were very unfavorable. The ground was dry and hard to plow; in many cases turned up in large lumps which farmers were unable to make fine for a good seed bed. Conditions in the fall were not favorable for growth, so that when winter came on the plant was small and ill-fitted to stand the storms of an ordinary winter in this State. All this happened with many farmers who had done their very best to give the crop a good start. But right here Nature smiled propitiously and exerted its influence. All through the long winter in most parts of the State the ground was seldom frozen and was covered with a blanket of snow which enabled the plants to continue to grow. The winds in March failed to uncover the fields so that vegetation might be subjected to the alternate freezing and thawing so common in that month and which is so destructive to plant life. The rain fell at just the right time in the spring and all conditions continued favorable, so that in the end we had a crop that averaged in the State 19.43 bushels per acre, a yield that, according to statistics, was only exceeded but once, when the crop of 1885 yielded 19.91 bushels per acre. In the aggregate it was the largest crop ever grown and instead of being due to rich land well prepared, something over which man has some control, was largely the result of very favorable climatic conditions, something beyond the province of man to influence and control to any great extent.

One year later conditions were exactly reversed. The seed bed was well prepared and the crop covered the ground nicely by winter time. In February we had a very severe storm, the temperature remaining exceedingly low for several days, freezing the ground for several feet in depth, and thus killing many trees and plants. Whether this severe

weather did the damage or whether it was the result of conditions that occurred later, at any rate the crop of wheat for 1899 was the poorest ever grown in the State to that time. The failure was nearly universal, the crop yielding about eight bushels per acre, while the average for the last twenty-five years is over sixteen bushels per acre. In accordance with the rule that misfortunes never come single handed, the farmers of this State were obliged to harvest a still poorer crop this year, largely due to the ravages of the Hessian fly. Thus it will be seen that in the last three years we have had the best crop ever grown and two of the poorest crops of wheat ever grown in this State, and the factors that brought about the result in each case were largely beyond the control of anyone.

While it is not fair for an optimist to point to the crop of 1898 when referring to Michigan as a wheat growing State, neither is it fair for a pessimistic person to assert that it does not pay to raise wheat in this State, and then cite the last two crops as proof of the assertion. It is lamentable that we have had two failures in succession because of the loss entailed to the farmers, yet on the whole it must be admitted that very little could have been done to avert it.

It is well that we note and record all facts that occur in connection with our business, even though we have nothing to do with shaping events; still it is far more important that we should study that part of our own work that depends upon the effort we put forth and the manner in which it is done. There are a number of things in connection with farming in general that have gone wrong, and all because man willed it to be so. These are the things that should attract our attention at the present time in order that we may quit some practices that have become common and adopt those that bring successes and prosperity.

The student of history has read of a time when Spain, now downtrodden and almost forgotten, was the most prosperous country in Europe. As the center of civilization drifted westward, likewise did the center of wealth and prosperity move in that direction. Now and then one may find perhaps a section of country that has continued to be rich and prosperous and has maintained the fertility of the soil throughout the centuries that have passed. Generally these are favored spots, like the valley of the Nile, where the kind hand of Providence annually deposits that which the unprovident mankind of today seeks to rob from the soil. One hundred years ago there was more business, more life and activity in the valley of the Hudson than there was in the valley of the Mississippi, and a thousand New England hills, now dotted here and there with abandoned farms, yielded bountiful harvests to those who tilled them. The early settlers in this State, largely the forefathers of the people of today, came, in most cases, from that same good old New England stock, and were led to make the journey to the West by the many opportunities that were offered here for gaining a home and making a fortune. And now, after all these years, we have in turn many friends and descendants who have gone still further west, attracted by the same siren's song which has enchanted and led people since the dawn of civilization. But this tide has now reached the Pacific Ocean, where it must stop, since it has encircled the earth. What the farmers of this country should have done on their own motion they will now be compelled to do as a matter of necessity. Extensive

farming must be given up for that which is intensive, a system which, on the whole, tends to enrich the land year by year and also grow profitable crops.

While it is not universally true that the farms of this State cannot grow crops any longer at a profit, yet there are sections in some of the oldest counties where this is true. Land that once produced good corn and wheat is now too poor to grow grass. It is not only true of Michigan, but of every other state in the Union where farming has been carried on as long as it has here. Before the average price of wheat dropped so much below $1 there was a great deal of money in the business and farmers generally grew all they could of it. When the western states began to grow so much wheat, thus, with other things, depressing the price, some people began to change their methods, and instead of depending largely on the one crop, diversified their farming and thus continued to be fairly successful. Others continued in the same old beaten path, did not modify their rotation of crops, but kept on growing wheat after wheat, until today we can find many an impoverished farm, with its owner on the verge of ruin. After having harvested two exceedingly poor crops, we find many ready now to quit the business altogether, with the idea in view of turning their attention to some other line of farming.

We believe that it is unwise for Michigan farmers to make any radical change in their business. It is evident to us that wheat will continue to be for many years to come one of the great money crops in this State, and there is plenty of evidence to demonstrate that it can be grown profitably on high-priced land in any ordinary year. We have in mind at the present time a section of country where the crop of 1900 must have averaged at least twenty bushels per acre, since many fields yielded as high as thirty bushels per acre. Let it be understood, though, that the farmers in the place referred to did not make a specialty of growing wheat. They were principally engaged in producing milk and butter, and, instead of selling hay and oats, these articles were fed to the cows, and in the course of time fully 95 per cent of the elements of fertility taken out of the soil by these crops were returned to the land again. Clover is grown in abundance because it furnishes pasture for the cows, the best hay for milk, and on the whole the one crop that yields bountifully and still leaves the ground richer than before it was sown. On such farms, and there are many of them throughout the State, wheat in nearly every instance finds a place in the rotation. One reason is because it is the best crop with which to sow clover for new seeding. It furnishes straw for feed and for an absorbent in the stables. It is often sown on the corn fields after the crop has been cut and put in the silo. This makes the expense of sowing very light and also the seed bed is just in the condition desired.

We also have in mind another neighborhood on one of the most beautiful prairies in southern Michigan, where for the last fifty years wheat has been the main crop. For a time, with a great reserve of plant food in the soil, good crops were grown. Clover was grown there, too, but eventually the clover root borer destroyed the crop for several years in succession, and in consequence of which the soil lost materially in fertility. This made it more difficult to get a seeding of clover started, and all the while wheat after wheat was being sown, hoping that the next time they would succeed in getting a catch of clover. As a result of

this and other causes to which we have called attention, there was poor wheat in that neighborhood where a failure had not occurred within the remembrance of the oldest citizen. The failure came because clover was the only method adopted, of any consequence, for restoring the fertility of the soil. When that failed the land became poor very rapidly. No stock of any consequence was kept and hay and grain were sold in the markets of the neighboring cities. For years the bulk of the straw was sold to the paper mills, thousands of tons going there at prices that paid very little more than the cost of hauling. Time and again had they been warned that such farming did not pay, that intentional soil robbery was just as bad as highway robbery, and the last tw crops, yielding from one to four bushels per acre, with hundreds of acres not cut at all, were simply object lessons indicating the wrath that is to come wherever the people willfully violate the laws of nature.

The farmer, who makes a specialty of growing potatoes, finds that a three years' rotation of clover, potatoes and wheat is advantageous. The clover enriches the soil and keeps it loose so that the potatoes can grow and develop uniformly; the wheat is sown at a slight expense, thus materially lessening the cost of production. The most satisfactory crop of wheat that I ever grew was after potatoes. The crop was dug so that the wheat was sown on October 9. This is rather late, but the plant got a fair start. In the spring the wheat looked even, but was small, and there was not a visible sign to denote that a good crop was in sight. The straw at harvest time was just right to cut nicely, so that the fifteen acres were easily put in the shock in one day, and, being well headed, yielded thirty bushels per acre. In an adjoining field was a crop of twenty-five acres on clover sod. The ground was so hard that it needed a sulky plow to turn it. It was so cloddy that much time was spent in preparing the seed bed, which in fact was never what it ought to have been. The crop grew good, though, so that at harvest time it was a great mass of tangled grain. It was slow and hard work to harvest it, and when threshed only yielded twenty-five bushels per acre. I doubt if there was much profit in the crop, since nearly every stage in the production cost from two to five times what it did when wheat was sown after the potatoes.

Many farmers follow beans with wheat, using a four-years' rotation of clover, corn, beans and wheat, with occasionally a crop of rye for fall and spring pasture in between the corn and beans. By thus adopting a short cut, wheat can be successfully grown in this State if the price is low. No other crop fits so nicely in many different rotations.

Many farmers have dropped special grain farming in Michigan, and it would be well if others would follow in their footsteps. The day is at hand again when it is profitable to produce beef and mutton, and when the time comes in which farming is so diversified in Michigan, that we sell meat and wool, and flour, and butter, articles containing the least possible quantities of the fertility of the soil, and feed on the farm the hay and grain, the milk and bran, instead of selling them in the open market, eventually taking back to the soil the elements it gave up, then will it be possible to again grow successfully fields of golden grain year after year; and every farmer studying the laws of the universe and abiding by their mandates, will build better than he ever hoped he could, bringing prosperity and contentment to those of his own time, and leave a rich inheritance indeed to succeeding generations.

THE BEET SUGAR INDUSTRY IN MICHIGAN, 1900.

THE RELATION OF THE MANUFACTURER OF BEET SUGAR TO FARMERS AND THE LABORING CLASS IN MICHIGAN.

C. D. SMITH, M. S., DIRECTOR MICHIGAN STATE EXPERIMENT STATION.

As early as 1890 and 1891 the Experiment Station of the Michigan Agricultural College had distributed sugar beet seed, which it had imported directly from Germany, among farmers scattered well over the State. The analyses of the beets had shown that roots containing a high per cent of sugar could be grown in all parts of the State south of a line drawn east and west through the southern boundaries of Manistee and Iosco counties. After that year, and up to the beginning of 1897, there had been frequent failures in the wheat crop and in the fruit crop along the western borders of the State, two of the principal sources of income to the agriculturists. Owing to drouths and depredation of insects the clover crop had partially or, in some sections, wholly failed. There was for these reasons an active demand among farmers for some new crop that should be profitable.

The United States Department of Agriculture sent to the Michigan Experiment Station, early in 1897, a considerable amount of beet seed, which it was my duty to judiciously distribute to still further determine the best localities for growing beets on a commercial scale. The seed was distributed and the results of the analyses of the products of the various counties are reported on page 149 of bulletin 150 of the Michigan Experiment Station, which is hereto attached as part of this statement. Your attention is respectfully called to the history of the beets grown by Higgins & Lenders, and others in Saginaw county, in 1897, as reported on page 137 of this bulletin. You will note the high per cent of sugar and the most excellent, and occasionally incredible, yield per acre, remembering that the yields were in many cases largely estimated, though estimated from weights and measurements.

This work in Saginaw was no inconspicuous factor in determining the location of the first factory to be erected in the State, that of the Michigan Sugar Company, at Bay City, fourteen miles north of Saginaw, and on Saginaw Bay.

Beet seed was distributed again in 1898, and, later, in 1899, to selected farmers widely scattered over the State. In both these years the beets were grown in plots larger than a quarter of an acre each. The results of the work for the three years are given in the following table:

Counties.	1897. Total number of samples.	1897. Per cent of sugar in them.	1897. Co-efficient of purity.	1898. Total number of samples.	1898. Per cent of sugar in them.	1898. Co-efficient of purity.	1899. Total number of samples.	1899. Per cent of sugar in them.	1899. Co-efficient of purity.
Alcona	.....	.....	.....	1	18.09	69	.....	.....	.....
Alger	1	14.22	80	.....	.....	.....	.....	.....	.....
Allegan	3	15.67	86	.....	.....	.....	5	15.79	83
Alpena	2	15.01	80	.....	.....	.....	.....	.....	.....
Antrim	2	15.97	82	.....	.....	.....	.....	.....	.....
Arenac	8	16.77	85	2	15.18	86	.....	.....	.....
Baraga	1	14.10	76	.....	.....	.....	.....	.....	.....
Barry	4	14.90	81	.....	.....	.....	12	13.15	79
Bay	10	15.53	84	4	14.86	80	.....	.....	.....
Berrien	3	17.83	81	.....	.....	.....	1	13.06	79
Branch	3	16.62	84	1	16.85	83	.....	.....	.....
Calhoun	6	15.82	84	1	12.98	79	1	15.22	85
Cass	2	15.44	82	.....	.....	.....	4	13.02	76
Charlevoix	7	17.58	87	.....	.....	.....	.....	.....	.....
Chippewa	.....	.....	.....	1	17.36	93	.....	.....	.....
Clare	1	16.80	84	1	19.03	89	.....	.....	.....
Clinton	4	15.89	84	1	15.99	88	1	13.39	71
Crawford	1	15.25	81	.....	.....	.....	.....	.....	.....
Delta	.....	.....	.....	.....	.....	.....	1	11.87	75
Eaton	5	17.50	83	2	14.82	83	7	13.38	79
Emmet	1	15.02	82	.....	.....	.....	.....	.....	.....
Genesee	6	14.75	82	1	18.69	86	19	14.75	81
Grand Traverse	7	15.75	82	1	21.18	91	.....	.....	.....
Gratiot	6	16.09	83	2	17.28	89	5	15.97	81
Hillsdale	2	16.71	84	.....	.....	.....	3	10.76	78
Huron	6	17.47	85	1	16.85	83	15	15.58	80
Ingham	36	16.43	87	5	13.72	79	7	13.00	77
Ionia	4	16.36	82	.....	.....	.....	.....	.....	.....
Iosco	6	13.18	.....	.....	.....	.....	4	16.06	83
Iron	1	18.18	80	.....	.....	.....	.....	.....	.....
Isabella	4	14.09	78	1	14.88	87	4	12.86	77
Jackson	7	9.74	74	1	16.60	86	10	14.76	80
Kalamazoo	16	15.45	82	10	13.40	82	.....	.....	.....
Kalkaska	2	16.91	83	.....	.....	.....	.....	.....	.....
Kent	16	15.55	83	1	15.42	85	19	15.15	76
Lapeer	2	17.71	84	.....	.....	.....	1	15.00	85
Leelanau	3	18.77	89	.....	.....	.....	.....	.....	.....
Lenawee	5	15.96	85	2	15.03	88	.....	.....	.....
Livingston	2	14.34	80	.....	.....	.....	1	14.03	80
Mackinac	1	16.22	85	.....	.....	.....	.....	.....	.....
Macomb	11	16.11	82	.....	.....	.....	16	14.10	80
Manistee	6	17.09	84	2	16.13	85	.....	.....	.....
Marquette	5	16.54	85	.....	.....	.....	5	13.67	80
Mecosta	4	16.67	84	1	16.42	86	2	13.81	80
Menominee	6	16.58	84	1	17.98	93	4	14.73	82
Midland	2	17.62	86	1	15.99	85	.....	.....	.....
Missaukee	1	15.79	84	.....	.....	.....	.....	.....	.....
Monroe	2	16.41	84	4	12.61	79	1	14.56	83
Montcalm	2	17.64	83	.....	.....	.....	.....	.....	.....
Muskegon	9	16.03	85	.....	.....	.....	.....	.....	.....
Newaygo	13	16.11	81	1	15.84	82	1	15.83	83
Oakland	7	15.29	83	4	14.11	81	1	17.50	88
Oceana	11	16.54	86	1	15.66	83	.....	.....	.....
Ogemaw	.....	.....	.....	1	17.78	88	.....	.....	.....
Ontonagon	4	15.15	79	.....	.....	.....	.....	.....	.....
Osceola	3	16.55	85	.....	.....	.....	3	15.60	83
Oscoda	.....	.....	.....	2	18.14	86	2	14.83	84
Otsego	1	18.00	90	1	16.42	91	1	17.33	81
Ottawa	15	16.47	83	2	16.29	87	.....	.....	.....
Saginaw	127	15.99	84	.....	.....	.....	1	12.08	81

Counties.	1897.			1898.			1899.		
	Total number of samples.	Per cent of sugar in them.	Co-efficient of purity.	Total number of samples.	Per cent of sugar in them.	Co-efficient of purity.	Total number of samples.	Per cent of sugar in them.	Co-efficient of purity.
Sanilac	11	18.15	86	1	15.19	88	1	15.80	85
Schoolcraft	......	....	......	1	15.91	88	1	17.69	83
Shiawassee	4	16.89	83	1	18.61	88	3	14.72	81
St. Clair	31	17.53	83	......	....	......	2	15.72	84
St. Joseph	1	12.16	76	2	15.19	80	......	....	......
Tuscola	1	18.94	89	2	18.11	88	1	15.72	81
Van Buren	4	13.82	80	......	....	......	......	....	......
Washtenaw	4	16.10	84	1	6.46	52	1	16.10	86
Wayne	9	16.12	84	2	13.10	80	16	13.44	79
Wexford	9	14.59	79	......	....	......	......	....	......

A glance at the above table would lead one to suppose that the average quality of beets in the State was much poorer in 1899 than in 1897. It must be remembered that the plots in 1899 were never less than a quarter of an acre and usually from one-half acre to five acres in area. In selecting the beets for analysis average beets were taken in 1899, while in 1897 selected beets were sent. Moreover, the season of 1899 was far less favorable to the development of sugar in beets than was the season of 1897.

The work of the station having shown that most of the area of Michigan was adapted to the production of a fair yield of beets of more than average content of sugar, the bulletins showing these results having been widely scattered, the next step was the location of sugar factories at suitable points. In selecting these locations, other factors than the character of the land and of the land-owners in the vicinity had to be considered. Prominent among these factors were pure water in large quantity, cheap coal and pure and abundant limestone. The question of the water supply is one of transcendent importance. A sugar factory uses several million gallons per day. The water used to soak the sugar from the beets must be free from such salts as would hinder the crystallization of sugar. The large amount used renders it impracticable to use water containing impurities, expecting to remove those impurities by any treatment whatever. Fortunately Michigan is well watered by springs, rivers and lakes containing water free from deleterious salts and sufficiently free from organic matter to obviate the necessity of filtering. It is possible, therefore, as far as the water supply is concerned, to locate a sufficient number of factories in the State to utilize as much of the soil for beet production as will ever be devoted to that purpose.

A bed of soft coal underlies the central part of the lower peninsula. It is now being worked at Saginaw, Bay City and the Saginaw Valley. Cheap coal supply is therefore provided.

Outcrops of limestone of satisfactory purity occur at several points in the State, and the work of the nine factories through the last campaign has shown that this factor can be supplied at low cost to all points of the lower peninsula.

The Experiment Station has made a host of analyses of water and limestone to determine their value for sugar-making purposes, the net

result of which indicates that from the manufacturer's standpoint nothing needed by sugar factories is lacking.

There yet remains to complete the list of supplies for sugar making the disposition of the farmer to raise the crop in quantity sufficient to supply the factories. The farmers of the State are for the most part either native-born American citizens or natives of Canada. They are accustomed to the growing of cereals on relatively large scale and not to that system of agriculture in which the application of a large amount of labor to a large area is involved. Repeated failure of accustomed crops has made them ready to welcome any new one that gave promise of adequate returns for the labor expended upon it. So great had become the agricultural depression due to successive failures of wheat and other crops that agents of the Canadian government and of the great railroad companies owning land in the Dakotas and states adjoining have succeeded, through the activty of shrewd agents permanently located at various points in the State, in securing a large migration of our farming population westward. There exists in Michigan today an organized emigration department which has succeeded since the beginning of 1900 in removing from Michigan several hundred people, chiefly tenants. If sugar beets bade fair to be a profitable crop the farmers were in the right condition of mind and experience to welcome it.

The Michigan Sugar Company, at Bay City, was the first to build a factory, their first campaign being in 1898. The exceptionally excellent results obtained at Saginaw in 1897 by Higgins & Lenders attracted the attention of capitalists to the advantages offered by the Saginaw Valley to beet-growers and sugar-makers. The Michigan Sugar Company was fortunate in having, as patrons, an agricultural community composed largely of Germans and Hollanders, many of them accustomed to raising beets in their native homes. They were therefore intelligent in their methods, and were at the same time working on a soil adapted to the business. The season of 1898 was in most respects favorable, although the fall was excessively wet, making harvesting difficult, unpleasant and expensive. The factory secured nearly all of its full complement of acreage, the farmers entered into the care of the crop enthusiastically, the harvest was abundant, and the financial returns to the farmer exceedingly satisfactory. I give here, by way of illustration, the results obtained by several farmers about that factory in 1898:

Name.	Area, acres.	Per acre.			
		Yield, tons.	Cost.	Receipts	Profit.
G. Hine	24	13.1	$41 25	$64 59	$23 34
S. F. Sayles	4	17.5	46 30	67 52	21 22
J. F. Boes	1	18.8	32 02	89 08	57 08
John Jones	3	14.	27 48	73 33	45 83
J. McKinney	3	18.	27 84	79 88	52 14
J. W. McIntosh	8	17.5	35 15	66 75	31 60
Thomas Handy	16	12.	31 63	57 34	25 71
C. B. Chatfield	13	14.5	38 82	65 25	26 43
T. F. Shepard	9	12.2	25 37	53 88	28 51
F. E. Webster	19	11.4	24 60	43 45	18 85

I cite these cases as examples of intelligent management of good soils in a favorable season. Frequent visits to the farmers about Bay City during the summer of 1898 convinced me that the community as a whole was enthusiastic in the belief that great profits were to accrue from the growing of beets. Other communities began to send committees to Bay City, and the good fortune of that factory in 1898 was without question one of the strongest inducements to both capitalists and farmers to invest money and work in sugar production in Michigan.

It was assumed that the almost phenomenal results obtained on a peculiarly favorable soil in a peculiarly favorable season by experienced beet raisers would be duplicated on less favorable soils by inexperienced farmers regardless of the season. Farmers all over the State were aroused from apathy and indifference to unbounded and unwarranted confidence in the certainty of profit from this new industry. From all parts of the State was heard the call for new sugar factories. Capital was ready to invest. The legislature had offered a bounty of one cent per pound for all sugar made from beets grown in the State, for which the factories should pay four dollars per ton for beets containing twelve per cent sugar. Eight new factories were built in the fall of 1898 and the early summer of 1899. Nine factories were therefore in operation in 1899. They are located as follows: three at Bay City, viz., The Michigan Sugar Company, The Bay City Sugar Company, and the West Bay City Sugar Company; The Alma Sugar Company at Alma, forty miles directly west of Saginaw; The Peninsular Sugar Company at Caro, east and slightly north of Saginaw; The Detroit Sugar Company at Rochester, Oakland county; The Kalamazoo Sugar Company, at Kalamazoo; The Wolverine Sugar Company, at Benton Harbor, Berrien county, and The Holland Sugar Company, at Holland, Ottawa county.

While the soil about these factories is far from uniform and not all of it adapted to beet growing, there is an amount of good beet land within reach of each factory to supply it with all the beets it can handle. The broad, alluvial Saginaw Valley, in which are located the three factories at Bay City, is undoubtedly the most promising section of the State from the standpoint of the beet grower. The water-table is within a few feet of the surface. The soil, while rich in organic matter, has an abundance of the needed mineral constituents. It is friable and easily penetrated by the growing roots, resembling in physical make-up, water-holding capacity and relation to the water-table, the valley of the Platte in Nebraska. The area, having once been the bottom of a broad lake, is almost or quite level. Much of the land, since grown over to beet growing, was formerly devoted to truck farming and gardening, lines of work which fitted both the farmer and the farm for the economical production of large crops of beets.

Near Alma the soil is for the most part a loam, tending toward a clay loam, rich in fertility and possessing a good water-holding and drouth-resisting capacity.

I submit in the table below some of the facts in the campaign of the factories in 1899:

Companies.	Net tons beets sliced.	Pounds sugar produced.	Pounds sugar per ton beets.	Acres in 1899.	Acres in 1900.
Michigan Sugar Co.					
Bay City Sugar Co.	40,064	6,942,130	173.2	6,780	5,519
West Bay City Sugar Co.	16,588.83	2,085,808	125.1	6,250	3,160
Peninsular Sugar Co.					
Detroit Sugar Co.					
Wolverine Sugar Co.	10,797	1,787,283	165.5	1,500	2,250
Holland Sugar Co.	16,871	2,584,099	153.1	3,700 2,400	2,000
Kalamazoo Sugar Co.					
Alma Sugar Co.	19.700	3,361,203	170.6	2,800	3,300

As to the quality of the sugar made, I am glad to say that it was generally a prime article. It must be admitted, however, that certain factories were, by reason of machinery not adapted to American conditions, unable to make a first-class article, and as a result the reputation of Michigan sugar in the markets is somewhat injured. Taking up the factories one by one, permit me to report certain details.

The campaign of 1899 was the second one for the Michigan Sugar Company, which had sliced during 1898 over 41,000 tons of beets, and had made therefrom 5.280,000 pounds of sugar. Its second campaign was marked by the fact that the experience of the year preceding, with th opportunity to improve machinery during the summer of 1899, had resulted in a campaign practically without accident or stoppage. The second campaign lasted 114 days. There are 190 men employed in and about the factory, 20 men working the entire year. The quality of the sugar is uniformly first-class. The factory was built by Fred W. Wolf Co., Chicago. The men employed are for the most part American-born and nearly all of them American citizens. The factory has a nominal capacity of 350 tons per day, although it has sliced as high as 400 tons per day for several consecutive days.

The Bay City factory has a capacity of 500 tons per day, with room for double that amount, and cost $500,000. The sugar is excellent in quality and is sold in Chicago very largely, some going to Michigan points. No dividend has been declared this year, the profits made being applied to retiring bonds and the betterment of the plant. Both of these factories use limestone from Trenton and Wyandotte quarries. The factory was built by the Kilby Manufacturing Company, of Cleveland, and is giving good satisfaction. It was in operation 110 days during the last campaign. There are employed in and about the factory 250 men, 30 of whom work the entire season, and 30 more during June, July and August in repairs and preparations for the coming campaign. The owners are at present installing a plant for drying the pulp and mixing with molasses, making a feed for cattle, which will be put upon the market, the bulk of it being already sold for export at a nominal advance over the cost of production. This dried pulp contains less than 10 per cent of water; it also contains 16.90 per cent of protein, with a high per cent of carbohydrates. The factory now has 5,519 acres contracted for the campaign of 1900.

The factory of the West Bay City Sugar Company was not finished in time to begin operations until nearly the beginning of the new year.

Its campaign was therefore necessarily short, and was unfortunately attended by several accidents which seriously interrupted the work. Owing to the lateness of the start in the last campaign many of the farmers that had contracted with this factory sought relief from their contracts and delivered their beets to other factories.

The Peninsular Sugar Company has located its plant at Caro, some 26 miles east and north of Saginaw. The building is a large one, and is fitted with machinery to consume 500 tons of beets per day, with opportunity to double its capacity. The good will of the farmers toward the factory is manifested by the fact that there are already subscribed for next campaign pledges for nearly 5,000 acres.

The factory of the Alma Sugar Company is located about 40 miles almost directly west from Saginaw in the center of a rich, populous and prosperous agricultural community. Like the other factories of the State it is backed by sufficient capital to insure success. The factory cost $450,000 and employs 500 men, mainly Americans, and will employ practically all Americans hereafter. As the table above shows, it had a fairly successful campaign in 1899, making 170 pounds of sugar to the ton of beets. There are already pledged 3,300 acres for the coming campaign as against 2,800 for last year.

The Detroit Sugar Company has located its plant at Rochester, not far distant from Detroit, with which it is connected by electric cars as well as by steam railroads. This factory made a relatively short run in 1899, but turned out a quality of sugar that was unsurpassed, and secured a larger per cent of sugar per ton of beets than any other factory in the State except the Michigan Sugar Company.

The Wolverine Sugar Company has located at Benton Harbor, in the extreme southwestern part of the State. Here the factory has to compete with fruit growing in the best fruit section of the State, and also with the raising of cucumbers and vegetables for large canning and pickling factories at Benton Harbor and St. Joseph. As a result of this competition the factory has secured its acreage this year very largely from Indiana. There are 2,250 acres now pledged for the coming campaign. The factory was put up by E. H. Dyer & Co., and cost approximately $300,000. Its work has been eminently satisfactory during the past campaign, the sugar being faultless and in demand both in Michigan and in Chicago.

The Holland Sugar Company, at Holland, differs in some respects from the other companies of the State. A large share of the stock is owned by farmers in the vicinity of Holland, who therefore are interested in the factory as well as in the growing of beets. Last year the campaign lasted 55 days. The sugar made was excellent in quality, and met with a ready sale at highest market prices. Acres in 1899, 3,700; acres in 1900, 2,000.

The Kalamazoo Sugar Company began its campaign late at their factory north of Kalamazoo. The run was short, and the supply of beets limited. The factory has pledged for next year, however, 5,400 acres, of which 2,200 acres are in Indiana, and 1,000 acres in Ohio. A series of accidents delayed the beginning of the campaign last fall, but the work was satisfactory when once operations fully began. The factory was erected by F. W. Wolf & Co., and cost $400,000.

The influences of the factories upon the agriculture of Michigan are

very important. In the first place, in the immediate vicinity of the factory, and near all railroad stations within 40 miles of the factory, it has appreciably increased the selling price of the farms. At Bay City there is now a greater activity in real estate transfers than has been witnessed in many years, and vacant houses in and about the city are very scarce. Farms have sold at a price per acre far in advance of offers of five years ago. A host of conversations with leading business men and farmers about Bay City lead me to believe that the net advance in real estate values due to the establishment of the factories cannot be less than 15 per cent, while cases are on record where specific farms have been sold at an advance, in one case of 25 per cent, and in another, a very large farm, nearly 50 per cent. Land rents for growing beets at from $5 to $8 per acre. About the other factories in the State the same appreciation of values is noticeable. About Holland, for instance, the rent of land for growing beets has gone from $6 per acre per annum to $8, $10, and, where the land was especially well located and of good quality, to as high as $12 and $15 per acre. At Holland there are canning factories and pickling works, which compete with sugar beets, and draw heavily upon the supplies of transient labor. I have visited Kalamazoo, and the other localities where factories are located, and find that this rise in the price of real estate has in nearly every case followed the erection of the factory.

In the second place, the by-products of the factory are gradually being used for feeding live stock, and for fertilizers. In Bay City the supply is so large that as yet but a small per cent is thus utilized. Near that city, however, I may cite the enterprise of Mr. W. A. Wilder, who fed last year several carloads of pulp to his dairy cows, and to young stock which he was wintering. The young stock were fed nothing but pulp, straw and a little hay. They had no grain. They are now in fair condition, ready to turn on grass. His dairy cattle received corn silage, hay, grain and beet pulp. The steers ate one and one-half bushels per day of the pulp, while the supply to the dairy cows was limited to less than one bushel per day. I found a growing feeling among the farmers of Bay City in favor of the pulp, and many teams are engaged up to late this spring in hauling it away. Many other cases may be cited where the pulp is fed extensively, and still others where farmers are preparing to ensilo it next year, expecting to rely upon it largely as succulent food for dairy cows and pigs.

The slaked lime is being used as a fertilizer on lands that need it near all the factories. Unfortunately, the molasses, rich as it is in potash, is at present entirely wasted.

So far, from the very nature of things, no American seed has been used on a commercial scale by our factories. The imported seed in 1899 was in some cases very unsatisfactory. The repeated tests we have made of the seed coming into the State this year show it to be of a very much better quailty. A systematic effort ought to be made at once to begin the growing of seed. This industry employs a great many men, and will demand the highest type of talent to insure success.

While at the outset it was necessary to employ experts in the various divisions of the factory work, and these experts had to be brought in from without the boundaries of the State, and even from without the boundaries of the United States, I am glad to report that Americans

are readily learning the business, and it will not be many campaigns before the American factories will be manned throughout by Americans.

The establishment of the factories has exerted a marked influence on the labor market. Employment has been given to men, women and children who would otherwise have been idle. During the months of June and July, and again in October, the factories have given rise to an active demand for persons, possibly not strong enough to do the hard work of a farm, but able to do light work, to thin, hoe, and harvest the beets. Near most of the factories the supply of such labor has not been sufficient. In the campaign of the Michigan Sugar Company in 1898, beet raisers found it possible to hire women at from fifty to sixty-five cents a day to thin beets. Later in the season, as the labor supply proved inadequate, these same women, and children as well, asked and received from seventy-five cents to one dollar per day. In 1899, about the same city, they have received habitually one dollar per day and dinner. The prices for this class of labor have varied from time to time and in different localities. About Benton Harbor the price per day rose to a dollar and a quarter and board. And about all the factories, in the very busy season, the daily wages rapidly rose to one dollar per day and upward.

I know of but one case where laborers were brought into the locality from a distance for the express purpose of doing the thinning and hoeing. This was at Alma, where a lot of men were brought from the city of Detroit to aid in thinning the beets, which, by reason of the extreme wetness of the season, had been too long neglected. The men were unaccustomed to field work, and disappeared at the first opportunity. In brief, then, it may be stated that the introduction of the factories has increased both the demand for labor and its value in the market. It has furnished employment to a large number of boys that would otherwise have been idlers, and to a possibly still larger number of women who were sorely in need of the money thus earned. Fortunately, the thinning and hoeing comes for the most part after the close of the common schools, and the topping is over soon after the beginning of schools in the fall. Thus the work interferes but little with the school attendance of the children.

The busy period of thinning and hoeing lasts about forty days, beginning in early June, and the harvest, beginning in September, lasts well into November, the lifting and topping occurring in September and October, and the hauling to the factory continuing through to January and even later.

The plan of furnishing employment during the summer in the fields to the men engaged in the factory in the late fall and winter will be tried this season by one factory.

My investigations at all the factories convince me that the establishment of this industry has so far resulted in no serious disturbance of economic conditions relating to the labor market. There have been times near all factories when labor has been scarce and exceptionally high prices have been paid. On the whole, however, there has been a fair supply to meet the active demand. Mature laboring men have found remunerative employment, and the congestion of labor in the cities noted in former years has been less conspicuous this season than

heretofore. I believe the work of the sugar factories has been one contributing cause to this healthy economic condition.

This demand for labor is fairly certain to be permanent, as it seems hardly possible that any machine can be invented that can take the place of the human hand and eye in the operation of thinning, while to thin an acre of beets planted in rows eighteen inches apart will require the work of an active boy or woman fully six days.

Turning now to the farmers' side of the business, we come to the question of cost of production. We have raised many acres on the College farm, and I have visited repeatedly every beet growing section of the State. By the co-operation of a large number of intelligent beet growers, I am able to give approximately the average cost of growing beets in the State at large. Here are the items, some of them estimated, it is true, but all of them based on actual and extended experience:

	Cost per acre.
Plowing, usually subsoiling	$2 50
Harrowing, several times	1 00
Seed	2 50
Sowing	50
Cultivating, six times	2 40
Thinning and weeding, and hoeing	8 00
Pulling and piling	2 00
Topping	6 00
Drawing, average 2.5 miles	6 00
Freight, 17 tons at 20c	3 40
Unloading	1 13
Total	$35 43

This is, of course, an average with all the imperfections that that term implies, and does not take into account the rent of land and cost of fertilizers. It gives a rough estimate, however, of the actual cost to the farmer, and leaves for him next, the question whether the resulting crop will be sufficient to give him a profit over this cost.

The size of the crop is contingent on the season as well as upon the soil and the skill of the farmer. The season of 1898 had been favorable; the season of 1899 was distinctly adverse. The spring was late and very wet though May and early June. The temperature for the same period was below the normal. As a result, the early sown beet seed did not germinate and resowing was deemed necessary. The wet May was succeeded by a dry and very hot late June, July and August. (See page 103 in bulletin 179.) The crop over the State was, therefore, well nigh a failure. On all the sandy lands the crop was practically a total failure. On the light loams it was better, and on the alluvial soils tending toward muck, it was best of all. Notwithstanding the adverse season some farmers harvested as high as 18 to 20 tons per acre and made a fair profit. On the other hand, other farmers lost practically all the time and money spent on the crop. Some farmers sowed the seed on well prepared land, thinned the beets, and then abandoned the fields; others carried their crop through the season to the harvest, but to meet serious loss and grave disappointment. A

visit to beet growers in the various sections of the State, and to the factories where the beets were delivered, makes me positive that the average yield for the State of acres harvested in 1899 did not exceed seven tons. I question whether it exceeded six. In sandy localities many acres were plowed up without loss farther than the seed, as the fields were utilized for other crops. This failure by reason of the adverse season has made the farmers hesitate about raising beets this year, has covered the whole proposition with a dark cloud and made the attitude of the farmers as a class, while not hostile, certainly not encouraging, and the factories found it difficult to secure sufficient acreage for a full campaign in 1900.

A second result of the adverse season has been a pressure upon the factories for a higher price for the beets and for other concessions. To this pressure the factories have yielded. The price, this season, will be $4.50 per ton for 12 per cent beets, with an addition of 33 1-3 cents for each per cent of sugar in the beets over 12. Some factories are paying the freight on the beets to the factories. In some cases the beets are unloaded free of cost, and in others the beets are received at any time, and the farmers are not forced to pit them, with all the labor and cost attendant upon that operation.

The beet growers about Bay City have organized an association for mutual instruction in the art of growing beets economically, and for the further purpose of securing better prices for their products. The association was formed in the late summer of 1899, and has held frequent meetings through the winter and early spring. I cannot give the present actual membership, but am confident that over fifty per cent of the growers tributary to the three factories are affiliated with it. Similar organizations are found at Kalamazoo for the western part of the State. In some of the factories the growers will nominate the tare men and possibly have some voice in the selection of the weighman and beet tester, thus entirely removing all grounds for suspicion except in the single factor of determining mare.

The work of these associations cannot fail to be of some educational value to the members, and it is education of which the growers stand most in need. The growing of beets demands far more careful methods of husbandry than those to which our farmers have been accustomed. It requires better cultivation, better fertilization, and expenditure of more money per acre. It thus broadens the mind and the methods of the farmers.

One of the main arguments at the outset against undertaking to make sugar from beets in Michigan was that the period between beet harvest and the final freeze up in the fall was too short. California and Nebraska had given little data as to either the possibilities of working up frozen beets or the cost of burying in pits, and thus protecting against frost. Our factories have had little trouble in working up frozen beets, but the cost of pitting and later removing from the pit and hauling to cars or factories has been a serious burden on the farmer. Owing to the limited capacity of the beet sheds which any factory can possibly construct, and the great bulkiness of the crop, it seems inevitable that the farmer must deliver his product in installments, as called for by the factories. To retain them safely they must be buried, as once freezing and thawing ruins the roots. The dread of this job of first cover-

ing the beet piles with dirt, and afterwards removing with pick and shovel the frozen covering, has deterred many farmers from beet growing. To obviate this serious difficulty, the Benton Harbor factory will undertake to receive all beets as fast as farmers can deliver them this year, or will pay the expenses of pitting.

I am constrained to believe that the wide extension of the beet growing at Bay City is due in no small degree to the most excellent stone roads radiating far out into the country in all directions, from the factories. Beets are hauled in long distances at small expense, simply because one driver with a three-horse team hauls not one ton, but possibly four, or even five, tons. The lack of similar thoroughfares is certainly hindering the proper growth of the busines elsewhere. At Alma the factory is contributing funds to aid the farmers in building and maintaining the gravel roads leading to the factory.

Over fifty per cent of the beets are hauled to the factories on cars which brings them from stations along the various lines from points up to forty miles from the factory. The beets are hauled to the station when loaded on wagons. Good roads are therefore needed and now demanded about the distant towns and villages where the beets are grown. In this way the helpful influence of the factories on the character of the roads is widely extended.

DOMESTIC SUPPLY OF SUGAR FOR MICHIGAN.

R. C. KEDZIE, D. SC., LL. D., PROFESSOR OF CHEMISTRY AT THE MICHIGAN AGRICULTURAL COLLEGE.

Abstract of a paper read by invitation before the U. S. Industrial Commission in Washington, D. C., May 15, 1900, by R. C. Kedzie, M. S., M. D., D. Sc., LL. D.:

The hope for a domestic supply of sugar for our people has been cherished in Michigan for years. In 1880 the Board of Agriculture bought a good supply of seed of sorghum (amber cane) and distributed among the farmers for trial, and in 1881 the legislature passed "An act to encourage the manufacture of sugar," exempting from taxation for five years the apparatus used in making sugar from cane, and offering a bounty of two dollars for every hundred pounds of sugar thus made. Under this law ten tons of sugar were made from sorghum and $404 paid as bounty. But it was found that sorghum, as grown in our State, was not profitable for making sugar, because the proportion of glucose to sucrose was too large to permit profitable manufacture of crystallized sugar.

SUGAR BEETS.

Attention was then turned to the sugar beet as a more promising material. In 1890 the College imported more than 400 pounds of the seeds of each of four kinds of sugar beets cultivated in Europe, being the best kinds raised in Europe. More than 1,600 pounds of such seeds were given to our farmers, with directions for planting, culti-

vating and harvesting the beets, requesting a sample of the beets for analysis. Four hundred farmers received the beet seed and two hundred and twenty-eight reported results and sent beets for analysis, reports being received from thirty-nine counties. The average content of sugar in the beet juice was 14.20 per cent, the coefficient of purity was above 80 degrees in two hundred specimens, and below 80 degrees in twenty-seven. The estimated yield of beets per acre was thirteen tons.

Having thus demonstrated the adaptedness of Michigan to produce sugar beets of high quality and well suited for making sugar, the College did not further push these investigations. The agricultural and chemical problems were solved, but capitalists and manufacturers were not ready to enter and possess this land of promise.

THE CAMPAIGN OF 1897.

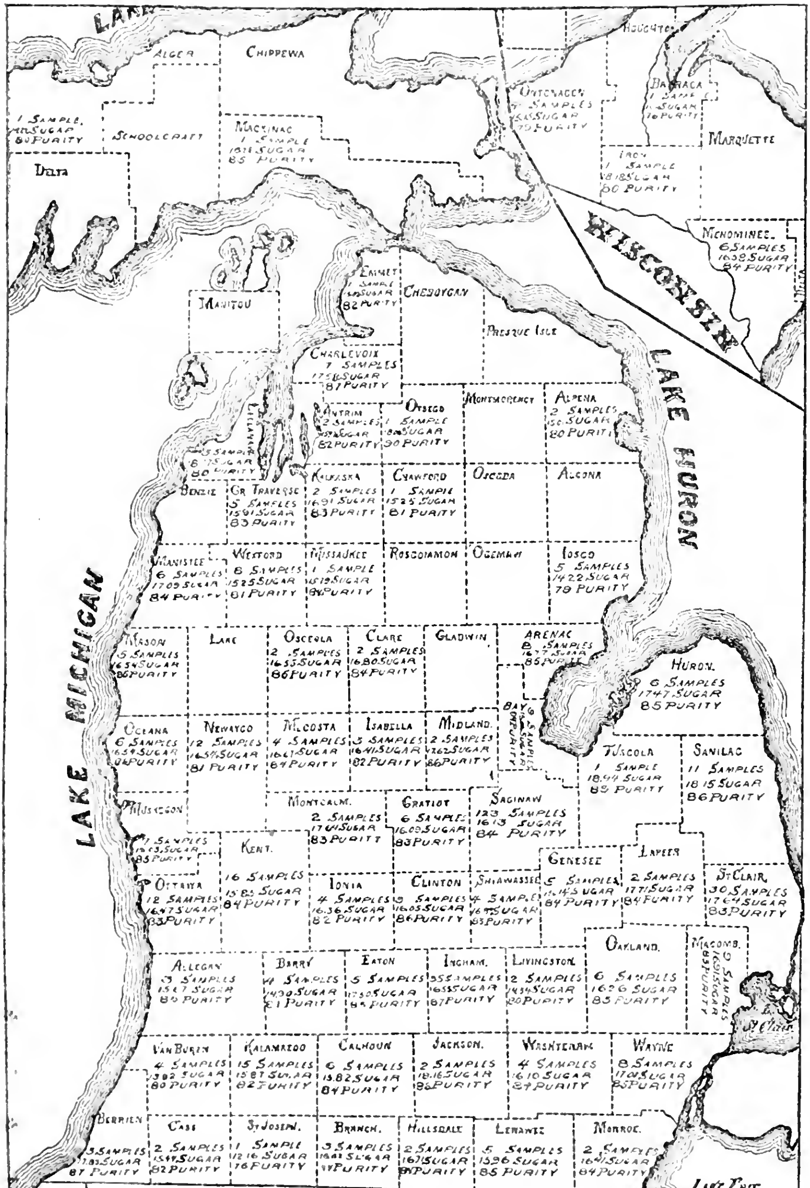
In 1897 general interest was again awakened in this subject, and legislation was secured to promote the manufacture of beet sugar. The lively interest taken in this subject by Secretary Willson of the Department of Agriculture greatly promoted the efforts of the College. The beet seed furnished by the Department of Agriculture was sent to a large number of leading farmers who would undertake to raise at least one acre of beets, also to a still larger number of persons whose work was of the amateur class. The season was only a fair one for sugar beets, the temperature for May and June being 3 degrees F. below the normal, and the rainfall in July being five inches above the normal, making cultivation difficult; but August and September were warm and full of sunshine, and October was nearly 5 degrees F. above the normal. The beet crop was quite satisfactory. The specimens of beets received for analysis numbered 493 and came from 64 counties. The average content of sugar in the juice was 16.08 per cent, and the coefficient of purity in 408 samples was above 80 degrees, while in 85 samples the purity was below 80 degrees, ranging from 62 degrees to seventy-nine degrees. In most of these cases of low purity the beets were grown on mucky soils.

THE MICHIGAN SUGAR BEET MAP

shows the area covered by this investigation, and gives data in regard to the sugar beet in the different counties.

To present the various facts embraced in the preceding tables relating to the growth of sugar beets in this State in 1897 in such shape that they can be seen at a glance, a sugar beet map is here inserted which shows the leading facts in regard to the experiments on this crop in our State for the year 1897.

This map shows by counties the number of samples of beets sent to the Experiment Station, the average content of sugar, and the coefficient of purity. The map speaks for itself:



MICHIGAN SUGAR BEET MAP, 1897.

The season of 1898 was favorable for the growth of sugar beets and the results showed this in the large percentage of sugar in the juice and the coefficient of purity.

SUGAR BEETS IN 1899.

The results of growing sugar beets in 1891 and 1897, and also in 1898, were so satisfactory, both in the quality of the beets and the yield per acre, that farmers looked for equally good results in 1899, but the weather for the growing season in 1899 was so unfavorable that in many localities the crop was very unsatisfactory. This was caused by the severe drouth during the growing season—the most severe for 36 years (1864-1900)—even worse than that of 1871, the year when Chicago was burned. The rainfall for the three summer months was 3.96 inches, where the normal rainfall is 9.50 inches. If we add to the actual rainfall, the rain of September, 1899 (2.14 inches), we obtain a total of 6.10 inches, or one-half the normal rainfall for the four months. The rainfall for these months in 1871 was 8.24 inches, or two inches more than in 1899.

In localities where the drouth was very severe the smallness of the yield from this new crop, from which so much had been expected, was very discouraging to the farmers, and in some of their meetings resolutions were adopted not to plant sugar beets. Other crops had suffered even more severely, notably wheat; but in the case of so well known a crop as wheat the loss might be charged to an inscrutable providence. Some farmers seemed to feel that, while the old, old charter of agriculture given to Noah, "While the earth remaineth, seed time and harvest shall not cease," would hold good for an old crop, like wheat, it could not be relied on for a new and untried crop like sugar beets. Yet a careful study of the nature and habits of a new crop and its adaptedness to our soil and climate, and to the methods of farming in our State, is a wise precaution.

Let me call your attention to the physical basis of sugar beet raising in our State.

THE SOIL OF LOWER MICHIGAN.

The physical basis for growing a beet crop is the quality and composition of the soil. In the lower peninsula the soil is technically known as the drift. The intermingling of many kinds of soil and the porous character of the deposit fit the soil for crops of the tuberous class. The lands adjacent to the great lakes and the southern half of the peninsula are adapted to the raising of all crops and fruits suited to our climate, and especially tubers.

Many years ago an invitation was extended to leading farmers in different counties of Michigan to send specimens for analysis of the leading soils which would fairly represent the agricultural soils of the county.

Twenty-eight soils taken from counties that fairly represent the sugar beet districts are here selected to show the chemical composition as specially related to the demands of this crop, giving the average percentage of lime, potash, phosphoric acid, and the physical condition which enables the soil to take up and hold water by capillary attraction, and thus withstand drought, or "water-capacity of the soil," are here presented:

AVERAGE OF THE MOST IMPORTANT ASH MATERIALS IN THE TWENTY-EIGHT SOILS.

Lime ($Ca\ O$)	1.13 per cent.
Potash ($K_2\ O$)	1.36 per cent.
Phosphoric acid ($P_2\ O_5$)	.33 per cent.

This table shows that the Michigan soils are rich in the ash materials required for sugar beets. Potash is in special demand for this crop, and these soils are remarkably rich in this chemical.

THE WATER-HOLDING CAPACITY OF SOILS.

The relation of the capacity of soils to hold water by capillarity to their power to produce crops is coming into prominence, as the result of recent investigations. Prof. Whitney of the Department of Agriculture is making extended inquiries in regard to this relation of soil and water in securing the best conditions for the production of special crops.

The quantity of water which dry soils will thus take up and hold varies with the kind and texture of the soil. If 100 grams of dry quartz sand are poured into a funnel, with a small filter to prevent the sand from running out, and water poured on the sand till completely wet, and the excess of water allowed to filter off, it will be found that this sand will take up and hold by capillary attraction 25 grams of water, or 25 per cent of its weight, which is its "water-capacity." If other soils are treated in the same way they will take up different percentages of water. A prairie soil on the average took up 62 per cent of water; fine soils from river bottoms, 57 per cent. The less water a soil will absorb the more rapidly it will part with it, both by filtration and evaporation. A soil whose water capacity is less than 33 per cent is liable to suffer in dry weather. Some soils by reason of their large water-capacity may carry crops successfully through a dry spell where other soils would fail for want of stored moisture.

In pronouncing upon the crop-producing ability of a soil, its water-capacity must be taken into account as one of the conditions of fruitfulness. Measured by this standard we find the Michigan soils are very satisfactory, as the average water-capacity of these 28 soils is 47.4 per cent—a good defense against drouth unless very severe and long continued.

RAINFALL IN MICHIGAN.

An adequate and distributed supply of water is an essential condition in agriculture. The average rainfall in central Michigan, as shown by 36 years' observation at the Agricultural College, is 32 inches; along the shores of the great lakes the rainfall is a little larger.

AVERAGE MONTHLY RAINFALL FOR THE SIX GROWING MONTHS.

May	3.23	inches.
June	3.50	"
July	3.23	"
August	2.77	"
September	2.72	"
October	2.44	"

This shows on the average an abundant rainfall for May, June and July, the period when the sugar beet requires plenty of soil moisture, when it is grappling with the soil and sending down its tap root to secure a hold upon the subsoil and derive its supply of food, both liquid and solid, from the deeper soil, and without absolute dependence upon the surface soil. In August there is an abrupt drop in the amount of rain, and a progressive fall in September and October—the season of our "summer dry spell," often becoming a veritable drought for many crops. This is the season of little cloudiness and abundant sunshine, when the beet is rapidly growing and packing its cells with sugar. If May, June and the first half of July are warm and moist, to establish and strengthen the growing plant, and if the balance of summer and autumn is hot and dry (short of drought), we have the ideal season for growing sugar beets. Essentially sugar is condensed and crystallized wind, water and sunshine, and requires for its development warm and sunny weather; if the weather is cloudy and rainy during these critical ripening months we would secure large beets and little sugar.

The distribution of rain during the growing months is a matter of importance. If we assume for most crops two inches of rain per month as the minimum, we find that during a period of 36 years in central Michigan, for the months of May and June, there was less than two inches per month for five times; in July, eleven times; in August and October, eighteen times, and in September, fourteen times. If the crop is not a surface feeder, like the grains, but a deep feeder, such as the tap-root plants, even less than two inches will suffice for a time. But if the plant is a sunshine feeder, the absence of moist weather is a matter of less consequence during late summer and early autumn, and may even be a benefit during the ripening season of the sugar beet.

It must be conceded that by reason of her soil, climate and peninsular position, Michigan is well adapted to the production of beets for making sugar. Another important condition is the intelligence and energy of our people. Some Europeans hold up their hands in horror at the presumption of our people in supposing that without years of training and drill, we have the audacity to assume that we can make sugar from beets in competition with the trained workers of Europe. What might be called presumption in others may be enterprise with Americans. After putting their hand to the plow our people are not inclined to look back. One evidence of our inclination to press forward is the bounty law of 1897, "to provide for the encouragement of the manufacture of beet sugar, and to provide compensation therefor."

The law provides that for a period of seven years a bounty of one cent a pound shall be paid to the manufacturer for sugar made in Michigan from sugar beets grown in this State, provided he shall pay to the producer $4 a ton for beets containing 12 per cent of sugar.

Under the stimulus of this bounty nine factories have been erected in this State and more are projected in the near future. The comfortable price paid at their very doors for this new crop made this change in rotation of crops very acceptable to farmers. To the three cash crops on the farm, wheat, meat and wool, the addition of sugar beets was welcome to intelligent farmers, and the price of farm lands in the vicinity of the factories increased rapidly. To look at this subject through the farmer's eyes, inquiry was made of a farmer who had just unloaded

his beets in Bay City in 1898, "How do you like raising sugar beets?" "Pretty good! Look at my passbook and you see my beets average 14 per cent sugar, and I get $4.50 a ton cash." "How many tons to the acre?" "Twenty." "Then you get $90 an acre for your beet crop. How does that compare with dollar wheat?" "Dollar wheat ain't nowhar!"

Only one factory has received the benefit of the bounty law of 1897. The Michigan Sugar Company of Bay City received a part of the bounty in 1898. No bounties were paid in 1899, because no money was appropriated for this purpose, but claims for bounty that would call for more than $300,000 are now pending. So large a demand upon the State treasury, with prospective increase year by year, led the last legislature to reduce the bounty to one-half a cent a pound, appropriating $200,000 to pay this bounty, and repealing the act of 1897, with its cent-a-pound bounty. The Governor vetoed this bill, leaving the State without funds to pay the bounty, yet leaving the law of 1897 in full force. What will be the outcome of this unfortunate conflict between the legislative and executive powers of the State is uncertain. Whether the State will finally resort to the speedy, respectable and modern form of repudiation, by declaring the act unconstitutional, remains to be seen.

OVER-PRODUCTION OF SUGAR.

With the large number of factories, present and prospective, fear has been expressed that there might be danger of over-production. Inquiry was made of the director of the Michigan Sugar Company, as to how much sugar his factory would turn out in the year? "About 6,000,000 pounds." "So large an amount will go far to supply the needs of the State." "If we can produce 7,500,000 pounds, that will only supply the needs of the counties of Bay and Saginaw." The use of sugar is constantly increasing and seems to keep even step with increasing supplies.

Our factories produce sugar so pure as not to need refining, but is ready for table use just as it comes from the factory; in German parlance, "Sugar of consumption, not sugar for refining." It does not have to pass through the hands of the sugar trust, and thus escapes the exactions of that great monopoly.

Michigan has the physical basis for producing beet sugar of the highest quality and in unlimited quantity. We have the soil and climate, the coal, limestone and pure water, the intelligent farmers and wide-awake business men required for so great an industry, and Michigan no more needs to import sugar than to send abroad for flour.

BEET GROWING AND SOIL FERTILITY.

Conflicting statements have been made about the influence of growing sugar beets on the permanent fertility of the soil. In Europe the raising of sugar beets has been followed by a large increase in the pro-

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MICHIGAN BEET SUGAR WINS AN AWARD.

Since the above was written announcement is received of the prizes awarded to American exhibitors at the world's Exposition in Paris, and in this list we are pleased to see that Michigan beet sugar is awarded a prize.

The Michigan Sugar Company of Bay City sent a barrel of their sugar to the Department of Agriculture in Washington, and this was sent as a part of the American exhibit at Paris. It might look like presumption to send beet sugar to one of the greatest producers of beet sugar with any hope of winning a prize.

When we remember that this Michigan sugar was the product *just as it comes from the factory*, exhibited alongside the refined sugars of France, yet awarded a prize in the original home of the sugar beet industry, we are surprised and gratified. It is like "Carrying Coals to Newcastle," and bringing home a prize from the colliers!

ductiveness of the soil. As Dr. Wiley told you yesterday, the average yield of wheat per acre in France has been increased from seventeen bushels to twenty-eight bushels since the introduction of sugar beet industry. In both France and Germany, the sugar beet is considered the best crop to precede a crop of wheat. The thorough and clean cultivation required for sugar beets, not only subduing the soil, but keeping out the weeds—the tramps and bums of agriculture—all contribute to the preparation of the soil for so exhausting a crop as wheat. It is not strange, therefore, that beet growing should increase the fertility of the land.

The commercial product of the sugar beet industry—sugar—does not contain a particle of fertilizing material; no potash, no phosphoric acid and no organic nitrogen. It is a pure carbohydrate, or hydrate of carbon, the carbon derived from the carbonic acid of the air, the oxygen and hydrogen from the rain, all these combined and elaborated under the force of the sun's rays in the laboratory of plant life, and thus sugar is produced out of wind, water and sunshine. No amount of pure sugar taken away from the soil can reduce its crop-producing power in the least. When Dr. Wiley's attention was called to this matter, he charged me to say to you that "the export of sugar cannot impoverish the soil."

Yet the sugar beet is called an exhausting crop. While pure sugar contains no fertilizing material, yet to grow the beets, to construct nature's laboratory where she makes her stores of sweetness, a large amount of fertilizing materials is required, and if the entire crop is removed from the field, speedy reduction of fertility will follow. It is the by-products other than sugar, the leaves, crown, pulp and molasses, that contain all the elements of fertility in the crop. If these are removed from the soil large quantities of potash, phosphoric acid and organic nitrogen must be applied to the field to compensate for this loss. But if all these waste products are directly or indirectly restored to the soil, loss of fertility is averted, and the ground made more productive. The leaves and crowns of the beets should never leave the field, being fed to stock or directly returned to the soil. The pulp should be converted into beef or milk by feeding to stock, and thus furnish manure, or be dried and preserved for distant or future use, as proposed in Bay City. Even the residual molasses, containing so much potash, should be fed to stock, and not allowed to flow into Saginaw river. If all these residues are finally returned to the field, the loss of fertilizing material on the farm will be prevented. But if these are wasted, a large supply of commercial manures, particularly potash and phosphates, will be required on our farms.

THE FARMER AND THE FACTORY.

The manufacture of beet sugar in this state is a kind of co-operative industry, in which the farmer and the manufacturer combine their efforts to produce satisfactory results. It is important that there should be harmonious action between the parties, and friction and even suspicion should be avoided. There are two points in the relations of farmers to factories where misunderstanding and friction may spring up.

1. Tare, or deduction from the gross weight of the beets as allow-

ance for adhering dirt and insufficient removal of the crowns of the beet, is largely left in the hands of the weighman, and must depend upon his honesty and good judgment. But this is a matter which is open to the direct inspection of the farmers, and any great injustice would soon receive attention from the parties interested.

2. Marc, or the deduction to be made from the amount of sugar found in the beet juice to offset the non-saccharine solids in the beet in order to determine the actual amount of sugar in the beets, is a subject demanding careful consideration. The determination of the marc does not come directly under the observation of the farmers, and they must take it on trust. It is a matter easily slurred over, and the farmer may be defrauded to an extent he little suspects.

The marc adopted for sugar beets by the Chemical Division of the Department of Agriculture is 5 per cent, and chemists generally agree with Dr. Wiley. The examination of sugar beets in this chemical laboratory gives almost identically the same factor. The students in our beet sugar class this season have examined this subject carefully. The results were not entirely satisfactory, because the beets used had been stored five months in a cellar, were somewhat wilted, and therefore gave too large a per cent for marc. The average results of many analyses reported by seven of these students are as follows:

White	5.30%	Marc.
Skinner	5.06%	"
Bauer	5.80%	"
McKinney	5.57%	"
Hargrave	5.58%	"
Dooley	5.75%	"
Westover	5.20%	"
Average of all	5.46%	"

Making allowance for the partially dried condition of these beets, it would seem that 5% marc for these beets, as they come from the soil, would be ample.

One of our senior class chose "The Composition of Sugar Beets" as the subject for his graduating thesis, using beets that had likewise been stored for several months. In thirty-three separate determinations the marc was found to be 5.45%. The marc, by Pellet's method (ten samples), was 4.93%. In all these trials water was used to remove the sugar from the pulped beet.

In extracting the sugar by the alcoholic method he found the process less satisfactory, because the sugar was not entirely removed by the alcohol, a sensible quantity of sugar remaining in the residue, from which water readily removed sugar by washing. In manufacturing, the sugar is not extracted from the beets by alcohol, but entirely by water. It would seem reasonable that the determination of the marc should also be made by water and not by alcohol.

A factory may arbitrarily select a marc to suit itself, quite different from that of the chemist. Instead of a marc of 5%, if he adopts a marc largely in excess, and the farmer is without notice of this severe cut in estimating his produce, serious injustice may result. It is possible

that a factory may offer large prices for beets and extra inducements for patronage and yet even up matters by fixing upon a marc of 10% or 12%. Dr. Wiley, at the "Round-up" of Farmers' Institutes at Ann Arbor, said that "any marc on sugar beets beyond 5% was robbery."

THE ESSENTIAL OIL INDUSTRY OF MICHIGAN.

HON. ALBERT M. TODD.

The essential oil industry of the United States is confined mostly within the limits of the State of Michigan, and to the production of oil of peppermint almost entirely, although other essential oils are distilled in a smaller way and to a slight extent in other states. Peppermint probably represents in value 90 per cent of all the essential oils combined produced in this country; hence this sketch will be devoted mostly to that plant alone.

The first printed mention of peppermint is found in "Ray's Historia Plantarum," published nearly three centuries ago, the plant being mentioned only as used in the dry state for medicinal purposes. The cultivation of peppermint and the distillation therefrom of an aromatic oil was begun first in a very small way in Mitcham, England, a hundred and fifty years ago, about twenty-five miles southwest of London. The beginning was exceedingy crude, the plants being placed in a little copper receptacle filled with water, over which a cover was fitted with clay, so that the steam should only escape through the opening made for the purpose, from which a pipe started, which passed through cold water by which the steam was condensed which contained the oil. The industry does not appear, however, to have developed very rapidly, as there was scarcely more than one thousand pounds of the oil distilled annually fifty years later, and it was not until its introduction into America, which occurred early in the present century, that distilleries in any commercial way were first erected in the State of New York.

The peppermint industry appears to have been founded in Michigan about 1835 and the plant was grown slightly in Ohio at the time, these two states and New York being the only states in which the culture has been undertaken in any commercial way until perhaps twenty years ago, when it spread to some of the northern counties of Indiana, near the Michigan line.

It is a matter in which the people of Michigan feel a just pride that the soil and climate of our State, probably affected by the salutary influences of the great lakes, as well as the progress and industry of her citizens, have enabled us not only to take the foremost place, but actually to make the industry in the State of New York, which for about fifty years held the chief place, a thing of the past. Whereas, fifty years ago three-fourths of the peppermint of the country was grown in New York, now less than ten per cent is produced there, while nearly, if not quite, seventy-five per cent is produced in Michigan, and the remainder in northern Indiana, joining our own producing district.

The planting, cultivation and distillation may be briefly mentioned as follows: Furrows are marked three feet apart, into which the roots and runners (root-stocks) are stretched by workmen, who carry them in sacks slung over their shoulders, so there shall be one or two living runners everywhere in the row. These runners are about a quarter inch in diameter and from one to three or more feet long, and are produced from the "new" mint the same season it is planted. They grow very thickly both above and just under the surface, meeting each other between the rows, so that after the crop is mown and raked it has the appearance nearly of a sod, on account of the young shoots of mint which start from these runners.

If the runners (or "roots," as they are generally, but incorrectly called) are good, well planted, with favorable conditions, a sprout will appear above the ground every two or three inches in the row in two weeks after planting, and more will continue to come for a month later. These runners have the same relation to the transmission of life that seeds do in wheat and clover, whereas the nutrition for growing the crop after the plant food in the runners is exhausted, is furnished by very fine hairy rootlets which appear about a month after planting, and which fill the soil at a lower level than the runners, but being so very fine have escaped the observation of many. There is a common belief that the runners (half of which are just below the surface of the ground) give nourishment to the plant, but this is a mistake.

Soon as the rows are visible, cultivating and hoeing begin, and are continued until July, when the last "weeding" is done by hand. Cultivation should, however, cease when the true roots reach out into the earth near the center between the rows, as they should not be disturbed too much by the cultivators. If during the succeeding winter the runners are not killed, there will be a "second" or "old" crop grow spontaneously without resetting, covering the ground like clover. Some farmers plow the ground over as soon as the first crop is harvested, and harrow it the second year, treating it more or less as they do the first crop, while some let it lie undisturbed, simply pulling the weeds by hand. Both plans have their advantages, but the replowing appears generally to be better, as it keeps the soil more friable, and protects the roots against winter-killing by covering them with earth, and also will destroy grasshopper eggs, which are often deposited in the fall, and which sometimes prove disastrous to the crop. It does not always happen that the plowing proves advantageous, depending upon the nature of the succeeding season.

The process of distillation is very simple, although, as in every other business, intelligent care, promptness and the best apparatus and implements are necessary for success. The mint after being mown is allowed to dry as much as may be without endangering the loss of the leaves and blossoms in handling, as they contain all the oil. After being properly "wilted," it is drawn direct to the distillery, where it is placed in large wooden vats, holding from one to two tons each. After a vat is filled a tight cover is closed over it and steam from a large engine boiler is let into the bottom of the vat through a valve. The oil is contained in microscopic cells in the leaves and blossoms, through which the steam passes, and which are ruptured by the heat, and the oil thus escaping from the leaves is carried upward with the

steam to the top of the vat, where it escapes through a "changing valve" to the condensing apparatus.

The steam, having been condensed, is a mixture of oil and water, which flows into the separating "receiver," where the oil collects on the top, the water passing out through an opening in the bottom with an overflow pipe, which rises on the outside to a point on a level with the fluid inside, as in ordinary chemists' receivers, intended to separate liquids of varying specific gravity. The water thus separated, however, holds a slight amount of oil in solution, hence it should be forced again into the boiler to be reconverted into steam and continuously used, having the additional advantage of being distilled and free from impurities which corrode the boiler. Most distilleries, however, allow this distilled water to run to waste. It was formerly bottled and sold in England, while the amount annually wasted in this country is several million pounds.

As the value of the oil depends largely upon its fine aroma, which can only be secured by the most careful cultivation and distillation, the successful production of peppermint requires constant care. Some growers carelessly allow weeds and other foreign plants to become mixed with the mint, which injures its aroma and purity, decreasing the value. Owing to more intelligent selection of soil, and improved varieties of plants, the yield per acre has increased during the past fifteen years, so that while formerly the average yield was not over twelve pounds, it is now over twenty pounds per acre. The price, however, has declined so rapidly, owing to over production, that even at the increased yield it has become unprofitable to most growers during the past two or three years. Formerly the price ranged generally from $2 to $5 per pound, and in some instances as high as $8, whereas the average price to the growers during the last two years has not been over 70 cents, at which price it is unprofitable. In order, however, to make up for the deficiency caused by the fall in price, growers have resorted to the expedient of curing the herb from which the oil has been extracted for rough forage for horses and cattle, which is called "mint hay." It is excellent for dairy cows, is an ideal food for sheep, and horses will "winter" on it nicely, although it is not suitable for them during the working season.

The writer has a mint farm in Allegan county of nearly two thousand acres, containing large distilleries with boilers for generating steam, running engines, etc., of about five hundred horse-power combined, and where he grows annually from eight hundred to one thousand acres of mint, besides other crops. On this farm a block of large stock barns has just been erected capable of accommodating five hundred cattle, with a storage capacity of about three thousand tons of hay and silage. The latter is contained in six silos about forty feet in height and from twenty to twenty-six feet in diameter. The silos are placed in the center, and from these the six wings radiate in six directions, like the points of a star. As the barn is built upon decomposed vegetation, which is soft and yielding, one hundred and sixty-eight piers of masonry were started on the "hardpan" below, the water being pumped out from each while being built. About one thousand loads of sand were used in the foundations for the silos and around them. It was found necessary, in order to keep the soil in sufficiently rich con-

dition to raise peppermint successfully, to return all the "mint hay" to the land, and this could be best accomplished by first feeding to stock, as it is difficult to plow under in the form it leaves the distillery. On this farm, "Campania," about one hundred men are employed during the busy season, and one hundred horses for performing the various kinds of work.

Among the other oils distilled in this country are spearmint, wormwood, tansy, wintergreen, sassafras and pennyroyal, but the combined value of all of these is but a fraction of that of peppermint alone. The amount of peppermint produced in the United States annually may be estimated at about 200,000 pounds, more than three-fourths of which is produced in Michigan.

MICHIGAN STATE AGRICULTURAL SOCIETY.

REPORT OF THE TRANSACTIONS OF THE SOCIETY FOR THE YEAR 1899, AND PROCEEDINGS OF THE WINTER MEETING OF THE EXECUTIVE COMMITTEE, JANUARY, 1900.

OFFICERS FOR 1899.

President—M. P. ANDERSON, Midland.
Vice-President—
Treasurer—C. W. YOUNG, Paw Paw.
Secretary—I. H. BUTTERFIELD, Agricultural College.

EXECUTIVE COMMITTEE.

Term ending January, 1900.

E. W. Hardy	Howell, Livingston county.
Frank Maynard	Jackson, Jackson county.
F. L. Reed	Olivet, Eaton county.
S. O. Bush*	Battle Creek, Calhoun county.
H. R. Dewey	Grand Blanc, Genesee county.
R. D. Graham	Grand Rapids, Kent county.
John Lessiter	Pontiac, Oakland county.
H. H. Hinds	Stanton, Montcalm county.
F. E. Skeels	Harriette, Wexford county.
M. J. Gard	Volinia, Cass county.

Term ending January, 1901.

Eugene Fifield	Bay City, Bay county.
L. W. Barnes	Byron, Shiawassee county.
W. P. Custard	Mendon, St. Joseph county.
William Ball	Hamburg, Livingston county.
W. E. Boyden	Delhi Mills, Washtenaw county.
Eugene Jones	Grand Rapids, Kent county.
J. E. Rice	Grand Rapids, Kent county.
C. A. Waldron	Tecumseh, Lenawee county.
John McKay	Romeo, Macomb county.
L. J. Rindge*	Grand Rapids, Kent county.

EX-PRESIDENTS.

Members Ex-Officio.

W. L. Webber	East Saginaw, Saginaw county.
George W. Phillips	Romeo, Macomb county.
William Chamberlain	Three Oaks, Berrien county.
A. O. Hyde	Marshall, Calhoun county.
T. W. Palmer	Detroit, Wayne county.

* To fill vacancy.

STANDING COMMITTEES AND EXECUTIVE SUPERINTENDENTS.

BUSINESS COMMITTEE.
Eugene Fifield, Eugene Jones and Secretary.

TRANSPORTATION COMMITTEE.
L. J. Rindge, Eugene Jones, S. O. Bush.

PROGRAM COMMITTEE.
Eugene Fifield, H. H. Hinds and Secretary.

RECEPTION COMMITTEE.
J. E. Rice, L. J. Rindge, M. P. Anderson.

PREMIUM LIST COMMITTEE.
William Ball, F. L. Reed, W. E. Boyden, John Lessiter, L. W. Barnes, Frank Maynard, J. E. Rice.

COMMITTEE ON RULES.
Eugene Fifield, H. H. Hinds, E. W. Hardy.

FINANCE COMMITTEE.
H. R. Dewey, F. E. Skeels, John McKay.

GENERAL SUPERINTENDENT.
Eugene Fifield.

CHIEF MARSHAL.
H. H. Hinds.

EXECUTIVE SUPERINTENDENTS.

Cattle—W. E. Boyden.
Horses, speed—Eugene Fifield.
Horses, Roadsters, Draft and Pony Classes—H. H. Hinds.
Sheep—John Lessiter.
Swine—L. W. Barnes.
Poultry—C. W. Waldron.
Dairy, Bees and Honey—M. J. Gard; G. H. True, assistant.
Farm and Garden Products—F. L. Reed.
Vehicles—S. O. Bush.
Agricultural Implements and Machinery—W. P. Custard.
Manufactured Goods and Supt. of Main Building—F. E. Skeels.
Art—F. E. Skeels.
Needle Work and Children's Work—Mrs. F. E. Skeels.
Special and School Exhibits, except Specials on Fruits—Frank Maynard.
Horticulture—R. D. Graham.
Gates—William Ball.
Police—E. W. Hardy.
Forage—W. E. Boyden.
Booths and Privileges—H. R. Dewey.
Miscellaneous Exhibits—John McKay.

PROCEEDINGS OF THE EXECUTIVE COMMITTEE.

The committee met at Sweet's Hotel, Grand Rapids, Monday evening, September 25, at 8 o'clock p. m.

Present: The president, secretary, treasurer, Messrs. Hardy, Maynard, Reed, Bush, Dewey, Graham, Lessiter, Rice, Hinds, Skeels, Gard, Fifield, Barnes, Ball, Boyden, Waldron, Rindge.

Superintendents reported large exhibits in their respective departments.

It was moved and carried that the Mail Carriers' Band be employed for evening exhibition.

The north office of the cattle barn was designated as the place for holding the election for officers.

J. E. Barringer of Macomb county, J. W. Cochrane of Midland county and John A. Hoffman of Kalamazoo county were appointed judges of election.

It was moved and carried that a caucus of the Society for the nomination of officers be held at the office of the president, on the fair grounds, at 3 o'clock p. m., on Wednesday, September 27. Adjourned.

CAUCUS.

Pursuant to call, a caucus of the Society was held at the office of the president on Wednesday, September 27, at 3 o'clock p. m.

William Ball was elected chairman and I. H. Butterfield secretary.

On motion, proceeded to nominate officers to be voted for at the regular election, as follows:

For president—M. P. Anderson.
For vice president—L. J. Rindge.
For treasurer—C. W. Young.
For secretary—I. H. Butterfield.
For members of executive committee for two years—E. W. Hardy, Frank Maynard, F. L. Reed, S. O. Bush, H. R. Dewey, R. D. Graham, John Lessiter, H. H. Hinds, F. E. Skeels, Dexter Horton. Adjourned.

The executive committee met at Sweet's Hotel, Grand Rapids, Thursday evening. The judges of election reported that the names placed in nomination at the Society caucus had received a majority of all the votes cast, and the president declared them elected.

OFFICERS FOR 1900.

President—M. P. ANDERSON, Midland.
Vice-President—L. J. RINDGE, Grand Rapids.
Treasurer—C. W. YOUNG, Paw Paw.
Secretary—I. H. BUTTERFIELD, Agricultural College.

Society address, Secretary State Agricultural Society,
Grand Rapids, Mich.

EXECUTIVE COMMITTEE.

Term ending January, 1901.

Eugene Fifield	Bay City, Bay county.
L. W. Barnes	Byron, Shiawassee county.
W. P. Custard	Mendon, St. Joseph county.
William Ball	Hamburg, Livingston county.
W. E. Boyden	Delhi Mills, Washtenaw county.
Eugene Jones	Grand Rapids, Kent county.
J. E. Rice	Grand Rapids, Kent county.
C. W. Waldron	Tecumseh, Lenawee county.
John McKay	Romeo, Macomb county.
John A. Hoffman	Kalamazoo, Kalamazoo county.

Term ending January, 1902.

E. W. Hardy	Howell, Livingston county.
Frank Maynard	Jackson, Jackson county.
F. L. Reed	Olivet, Eaton county.
S. O. Bush	Battle Creek, Calhoun county.
H. R. Dewey	Grand Blanc, Genesee county.
R. D. Graham	Grand Rapids, Kent county.
John Lessiter	Pontiac, Oakland county.
H. H. Hinds	Stanton, Montcalm county.
F. E. Skeels	Grand Rapids, Kent county.
Dexter Horton	Fenton, Genesee county.

EX-PRESIDENTS.

Members Ex-Officio.

W. L. Webber	East Saginaw, Saginaw county.
George W. Phillips	Romeo, Macomb county.
William Chamberlain	Three Oaks, Berrien county.
A. O. Hyde	Marshall, Calhoun county.
T. W. Palmer	Detroit, Wayne county.

Executive committee met at Sweets' Hotel, Friday evening, September 29, at 8 o'clock p. m. All members present.

Verbal reports were received from the executive superintendents relating to their departments.

On behalf of the committee, Mr. Ball presented a gold-headed cane to Mr. M. J. Gard, who retires as member of the executive committee.

On motion, Mr. Gard was invited to attend future meetings of the committee as an honorary member.

THE FAIR OF 1899.

The annual fair was held on the grounds of the West Michigan Agricultural Society at Grand Rapids, September 25 to 29, inclusive.

The weather throughout the week was stormy and unusually cold for the season of the year.

The exhibit in all departments was large, and, notwithstanding the weather, the attendance was greater than in 1898.

The report of the business committee, secretary and treasurer will show the result financially.

WINTER MEETING OF THE EXECUTIVE COMMITTEE.

The winter meeting was called to meet at Hudson House, Lansing, Monday evening, January 8, at 8 o'clock p. m. A quorum not being present, the meeting was adjourned to meet at Sweet's Hotel, Grand Rapids, Tuesday, February 20, at 8 o'clock p. m.

TUESDAY, FEBRUARY 20.

Committee met as per adjournment at Sweet's Hotel, Grand Rapids.

Called to order by the president.

Roll called, and the following members present: President, vice president, treasurer, secretary and Messrs. Fifield, Barnes, Custard, Ball, Boyden, Jones, Rice, Waldron, McKay, Hardy, Maynard, Reed, Dewey, Graham, Lessiter, Hinds, Skeels, Horton.

President Anderson delivered the annual address, as follows:

PRESIDENT'S ADDRESS.

Gentlemen of the Executive Committee of the Michigan State Agricultural Society:

The last exhibition of this society closed the half century of its usefulness. It is useless for me to dwell upon what has been done in the past as the history of the society speaks for itself. Many of us have been with it long enough to have seen it flowing with surplus wealth, and hustling at other times endeavoring to pay its debts. I regret very much that the centennial exhibition, which was one of the best in its history, was so handicapped by inclement weather. Almost any kind of business can stand a little wetting, but to be almost drowned, frozen and struck by lightning, all at nearly the same time, usually proves

disastrous. In all my past eighteen years' experience with the workings of this society I never experienced such as it had to contend with during its last exhibition. I had flattered myself that the semi-centennial was to go down in the society's history as one of the best both in class of exhibits and finances. In the former I was not disappointed, but in the latter I was, although I must confess that the final showing came out quite beyond my expectations, as I looked for a large deficit, while we were struggling with the weather. It is evident that the business management was all that could be wished, and every member did his best to make it a financial success. I wish to make a special mention of our general superintendent, Mr. Fifield, who threw his whole energy and business experience toward the success of the fair.

I cannot refrain from mentioning superintendent of booths and privileges, Mr. Dewey. When I received the final figures I found that he had collected and paid in $2,918.13 out of the mud, rain, freezing, cyclone week. I might make mention of others, but it would include the entire list of superintendents, as all worked together with a determination to make it a success.

ADVERTISING.

The committee the past year did not follow out the usual methods of advertising, but introduced a personal mailing method which proved to be wise, as the increase in railroad coupons indicated. It is a known fact that there were more people from a distance than ever before, which I attribute to the method of advertising and would recommend its continuation. The amount of railroad coupons, reaching nearly $6,000, is an indication of the benefit derived by the change.

FAIR DATES.

In past years the second week in September has proven, with very few exceptions, the best September week. From 20th to 30th, there is usually a disturbance in getting out of summer into fall, or the equinoctial period, that makes fair weather very uncertain.

EVENING ENTERTAINMENTS.

I was not favorably impressed with the proposition of night exhibitions, but inasmuch as a call for it seemed to be from a source that would suffer equally with the society should it prove a failure, the committee thought best to yield to the request, knowing that it meant the hardest kind of work and a great deal more responsibility, for the police department especially; and no one knows better what it means to have night attractions than Superintendent of Police Mr. Hardy, who left nothing uncared for, his plans being admirably carried out. Had the weather been warm and the lighting been perfect, a much larger attendance undoubtedly would have been secured. Unfortunately both weather and lights were a failure.

EXHIBITS.

The class of exhibits far excelled any previous exhibition in every department. Carriages, machinery, live stock and art hall never looked better, in my judgment, than they did at the last exhibition.

ATTRACTIONS.

The days have passed by when the people will be content with horses alone. There must be a mixed lot and no one can say that the attractions for 1899 were not of sufficient variety to please the people.

Had the weather been warm enough to have permitted the people to keep comfortably warm on the grand stand there would not have been standing room. The plan of "variety of attractions" I would recommend to be continued.

PROMPT ATTENDANCE OF SUPERINTENDENTS.

It is very important that each superintendent should be on the ground Friday morning preceding the fair. There are so many details and each superintendent has all he can do to care for his own department, hence it is his duty to be at his post, unless he is unable to be present; if so, he should notify the president, that he may have the department taken care of.

RENTS AND PRIVILEGES.

The announcement was made before the fair that all objectionable features would be promptly closed up. I have not learned that anything of the kind was admitted. As President Butterfield, in his annual address ably expressed, "The Midway at the Columbian Fair, followed by street fairs, allowed exhibitions that were not always consistent with good morals." I believe that the street fairs are as a rule conducted with the idea that it is everybody's fair; that anything the State Agricultural Society has ever had looked very tame when compared with the average street fair show.

The advance payment system adopted by the superintendent proved to be a success, as his report shows.

SCHOOL EXHIBITS.

This department seems to meet with much favor, as shown by the large increase in exhibits the past year, occupying more space than the needle department. I believe this a good branch to cultivate, as it brings the children of today in touch with the State society, who by and by will be participants in its management.

PREMIUM LISTS.

In my judgment premium lists should be printed and sent out at the earliest possible moment. I believe it would increase the interest and attendance.

TRANSPORTATION.

The past arrangements with the several railroad companies should be continued upon the mutual plan. A little confusion arose last fall, as the terms given by the railroad companies were not uniform. Under the head of Transportation (premium list, page 107), it says: "The following railroads will transport live stock, implements and articles for exhibition, to and from the fair, on the following conditions:

Flint & Pere Marquette.
Michigan Central and all branches.
Grand Rapids & Indiana.
Chicago & West Michigan.
Detroit, Grand Rapids & Western, Ann Arbor.
Chicago, Kalamazoo & Saginaw.
Manistee & North Eastern.
Lake Shore & Michigan Southern (except horses).
Grand Trunk System in Michigan (except horses).

Condition No. 4 says: "Shipments of race horses will not receive the benefit of this arrangement."

In the exception of the L. S. & M. S. and G. T. system, if they intended to apply only to race horses, it was a little confusing.

The co-operation of the railroads and the past relations, which have been of the most friendly nature, should be continued. The one fare for the round trip, with State Fair admission, meets with favor and is a mutual benefit to both railroads and society, as well as a convenience to visitors, as they avoid being caught in the rush at the ticket office.

FINALLY.

When we take into consideration the fact that the season of 1899 was, in regard to agricultural and horticultural products, almost a total failure, we should congratulate ourselves upon the splendid showing made, and not get disheartened, but enter into the coming campaign with renewed energy, maintaining the economic principles which this society has adopted, and I believe we shall be rewarded with success.

On motion, R. D. Graham, H. H. Hinds and L. J. Rindge were appointed a committee on president's address to report to executive committee.

REPORT OF THE SECRETARY.

I have received and paid over to the treasurer during the year—

For membership tickets sold	$510 00
For stall rents collected	245 10
Total	$755 10

The following gives the number of entries in each class, and the amount of premiums offered and amount awarded:

CATTLE.

Class.		Entries.	Amount offered.	Amount awarded.	
1.	Shorthorns	51	$285 00	$263 00	
2.	Devons	34	285 00	267 00	
3.	Herefords	46	285 00	267 00	
4.	Jerseys	55	285 00	278 00	
5.	Galloways	32	285 00	230 00	
6.	Aberdeen Angus	26	285 00	241 00	
7.	Holstein Friesian	13	285 00	125 00	
8.	Red Polled	24	285 00	226 00	
9.	Fat cattle	21	144 00	101 00	
	Totals	302	$2,424 00	$1,998 00	
					$1,998 00

HORSES.

10.	Standard bred roadsters	89	$267 00	$233 00	
11.	Roadsters—not standard	32	138 00	95 00	
12.	Carriage horses	35	160 00	131 00	
13.	Saddle horses	5	36 00	18 00	
14.	Horses for all work	21	236 00	110 00	
15.	Cleveland Bays	4	235 00	39 00	
16.	French Coach	3	235 00	39 00	
17.	Hackney	....	235 00	......	
18.	Percheron	28	235 00	156 00	
19.	Clydesdale or English Shire	9	235 00	73 00	
20.	Grade Draft	12	133 00	69 00	
21.	Shetland Ponies	....	Diplomas.	......	
	Totals	238	$2,135 00	$965 00	
					965 00 and 12 diplomas.

HORSES—SPEED.

No.					
1.	Free-for-all trot—not filled.				
2.	2:20 class—trotting	8	$300 00	$300 00	
3.	2:35 class—pacing	6	300 00	300 00	
4.	2:17 class—pacing	6	300 00	300 00	
5.	2:17 class—trotting	4	300 00	300 00	
6.	2:40 class—trotting	10	300 00	300 00	
7.	2:25 class—trotting	5	300 00	300 00	
8.	2:30 class—pacing	7	300 00	300 00	
9.	2:23 class—pacing	6	300 00	300 00	
10.	2:20 class—trotting	11	300 00	300 00	
11.	2:12 class—pacing	3	270 00	270 00	
12.	2:40 class, three-year-old—trot or pace	5	150 00	150 00	
	Totals	71	$3,450 00	$3,120 00	
					$3,120 00

SHEEP.

Class.					
22.	American Merino	92	$168 00	$168 00	
23.	Rambouillet Merino	46	126 00	126 00	
24.	Delaine Merino	62	126 00	121 00	
25.	Lincoln	40	114 00	114 00	
26.	Leicester	52	114 00	114 00	
27.	Cotswold	59	114 00	114 00	
28.	Shropshire	89	126 00	126 00	
29.	Hampshire	42	114 00	114 00	
30.	Oxford Down	103	114 00	111 00	
31.	Southdown	28	114 00	65 00	
32.	Horned Dorset	53	114 00	102 00	
33.	Fat sheep	13	54 00	36 00	
	Totals	679	$1,398 00	$1,314 00	$1,314 00

SWINE.

34.	Berkshire	46	$132 00	$132 00	
35.	Essex	28	132 00	69 00	
36.	Suffolk or Small Yorkshire	47	132 00	130 00	
37.	Poland China	50	132 00	129 00	
38.	Duroc Jersey	60	132 00	129 00	
39.	Chester White	29	132 00	130 00	
40.	Victoria	27	132 00	98 00	
41.	Tamworth	....	132 00	......	
	Totals	287	$1,056 00	$817 00	817 00

POULTRY.

42.		1,050	$528 00	$320 00	320 00

FARM AND GARDEN PRODUCTS.

43.	Grain and seeds	182	$107 00	$96 00	
44.	Vegetables	357	117 50	106 50	
45.	Display vegetables—professional gardeners	2	68 00	60 00	
	Totals	541	$292 50	$262 50	262 50

COUNTY INSTITUTE SOCIETY.

46. Fruits, grain, vegetables—no entries.

DAIRY.

47.	Butter and cheese { Butter	43	$90 00	$90 00	
	{ Cheese	11	60 00	60 00	
48.	Sugar, bread and pickles	73	51 00	41 00	
49.	Dried, canned and preserved fruits	28	90 00	90 00	
50.	Groceries for exhibition.				
	Totals	155	$291 00	$281 00	281 00

BEES, HONEY.

51.	Bees, honey and implements	18	$118 00	$57 00	57 00

FARM IMPLEMENTS.

52. For exhibition only.

	VEHICLES.				
53.	Wagons, carriages, sleighs, etc.	72			
	No money premiums.				
	MANUFACTURED GOODS.				
54.	Wool, robes, etc.	9	$46 00	$23 00	$23 00
55.	Articles—leather—no entries.				
56.	Furniture—no entries.				
57.	Stoves, ironwork, etc.—no entries.				
58.	Clocks, jewelry, etc.—no entries.				
	DEPARTMENT OF ART.				
59.	Painting and sculpture	254	$464 50	$421 00	
60.	Painting and drawing—amateur	97	99 00	70 75	
61.	Industrial art	16	79 00	6 00	
	Totals	367	$642 50	$497 75	497 75
	NEEDLEWORK.				
62.	Needle and fancy work—professional	135	$117 40	$96 65	
63.	Needle and fancy work—amateur	131	69 25	40 75	
64.	Needlework—either professional or amateur	36	17 50	14 50	
65.	Crochet and knit work	84	28 50	25 50	
66.	Children's work	19	32 75	8 50	
	Totals	405	$265 40	$185 90	185 90
	HORTICULTURAL.				
67.	Artistic exhibits	5	$38 00	$38 00	
68.	Collection, fruit—family use	3	60 00	45 00	
69.	Collection, fruit—market	2	44 00	25 00	
70.	Special exhibit—peaches	2	36 00	20 00	
71.	Special exhibit—pears	3	36 00	20 00	
72.	Special exhibit—plums	5	17 50	14 00	
73.	Special exhibit—grapes	3	33 50	24 00	
74.	Single plates	364	211 25	130 75	
75.	Plants and flowers in beds	4	60 00	60 00	
76.	Plants in pots	59	171 00	163 00	
77.	Cut flowers and designs	17	45 00	45 00	
	Totals	467	$752 25	$584 75	584 75
	Specials	259			
	Railroad fruit specials	....	$200 00	$200 00	
	Manufacturers in dairy class	....	Gold medal $144 50	Gold medal $62 50	
	Live Stock Record Association	....	615 00	615 00	
	Individuals in school specials	....	144 50	120 50	
	Society in school specials	....	107 00	101 50	
	Walter Burpee special	....	40 00	40 00	1,139 50
	Total				$11,565 40

REPORT OF THE TREASURER.

To the Executive Committee of the Michigan State Agricultural Society:

Gentlemen—I herewith submit the following as my report of the receipts and expenses for the year 1899:

RECEIPTS.

Balance on hand beginning of the year	$132 54	
Received from general admission at fair	9,775 75	
" " grand stand admission	1,295 25	
" " evening admission	234 75	
" " speed department	1,718 85	
" " superintendent of privileges	2,918 13	
" " membership	518 00	
" " stall rents	245 10	
" " railroad coupon tickets	5,625 25	
" " premiums overpaid	16 80	
		$22,480 42

DISBURSEMENTS.

Paid on orders of secretary and chairman of business committee	22,521 81
Balance overdrawn	$41 39

(Signed) C. W. YOUNG,
Treasurer.

The reports of the secretary and treasurer were referred to the finance committee.

The business committee submitted its report as follows:

STATEMENT OF THE BUSINESS COMMITTEE IN DETAIL.

Vouchers drawn, for what purpose and amount:

EXPENSES OF EXECUTIVE COMMITTEE.

Date, 1889.		No. of voucher.	To whom drawn and for what purpose.	Amount.	
Feb.	1	1	M. J. Gard, personal expense, winter meeting	$7 11	
	2	2	F. L. Reed, " " " "	7 87	
	2	3	H. R. Dewey, " " " "	11 10	
	2	4	H. H. Hinds, " " " "	6 18	
	2	5	Wm. Ball, " " " "	15 65	
	2	6	E. W. Hardy, " " " "	8 35	
	2	7	M. P. Anderson, personal expense, winter meeting	12 96	
	2	8	L. W. Barnes, personal expense, winter meeting	9 25	
	2	9	W. E. Boyden, " " " "	11 63	
	2	10	John Lessiter, " " " "	10 90	
	2	11	John McKay, " " " "	9 70	
	2	12	C. A. Waldron, " " " "	10 49	
	2	13	H. S. Fralick, " " " "	2 00	
	2	14	F. E. Skeels, " " " "	8 10	
	2	15	Frank Maynard, " " " "	9 08	
	2	17	Eugene Fifield, " " " "	10 48	
	2	18	I. H. Butterfield, " " " "	6 98	
Sept.	29	32	M. J. Gard, personal expense, July meeting	5 41	
	30	34	L. W. Barnes, " " " "	4 95	
	30	38	H. R. Dewey, " " " "	7 42	
	30	72	Frank Maynard " " " "	4 34	
	30	49	Eugene Fifield, " " " "	6 85	
	30	73	Wm. Ball, personal expense, April and July meeting	17 75	
	30	75	W. P. Custard, personal expense, April and July meeting	5 00	
	30	77	John McKay, personal expense, April and July meeting	7 70	
	30	83	W. E. Boyden, personal expense, April and July meeting	4 60	
	30	84	John Lessiter, personal expense, April and July meeting	6 75	
	30	85	F. L. Reed, personal expense, April and July meeting	5 11	
	30	87	H. H. Hinds, personal expense, April and July meeting	3 39	
	30	88	S. O. Bush, personal expense, April and July meeting	3 70	
Oct.	11	134	H. R. Dewey, finance committee	9 63	
					$250 43

PRESIDENT'S OFFICE.

Sept.	30	37	E. M. Sharp, clerk, services	$4 80	
	30	69	J. W. Cochrane, clerk, services	16 50	
	30	74	M. P. Anderson, personal expense	50 43	
	30	93	Thorpe Manufacturing Co., rubber stamp	2 00	
					73 73

SECRETARY'S OFFICE.

July	14	24	I. H. Butterfield, expenses	$19 55	
Sept.	30	64	I. H. Butterfield, part salary	250 00	
	30	109	I. H. Butterfield, expenses	32 75	
Oct.	11	132	I. H. Butterfield, part salary	333 10	
					635 40

TREASURER'S OFFICE.

Sept.	30	59	Old National Bank, livery	$4 00	
	30	66	C. W. Young, treasurer's salary	200 00	
Oct.	11	103	E. Parks, assistant treasurer's expenses	7 78	
	11	122	C. W. Young, treasurer's clerk hire	140 96	
	11	133	C. W. Young, treasurer's expenses	41 92	
					$394 66

BUSINESS COMMITTEE.

Sept.	30	48	Eugene Fifield, expenses, chairman	$53 50	
	30	49	Eugene Fifield, expenses, chairman	35 50	
Oct.	11	129	Eugene Fifield, salary as general superintendent	200 00	
	11	124	Eugene Fifield, expenses, chairman	9 35	
					298 35

CATTLE DEPARTMENT.

Sept.	30	83	W. E. Boyden, expenses, superintendent and judges	$44 30	
					44 30

HORSE DEPARTMENT.

	29	39	H. H. Hinds, expenses, superintendent and judges	$46 00	
	30	87	H. H. Hinds, expenses, superintendent	11 37	
					57 37

SPEED DEPARTMENT.

	27	28	Eugene Fifield, superintendent, to pay purses	$1,500 00	
	29	29	Eugene Fifield, superintendent, to pay purses	1,650 00	
	30	37	E. M. Sharp, assistant	10 00	
	30	40	Geo. S. Ward, clerk	60 75	
	30	41	W. F. Adams, starting judge	46 00	
	30	56	Powers, Tyson Printing Co., printing	10 90	
	30	65	Peter Brown, distance flag	2 50	
					3,280 15

SHEEP DEPARTMENT.

	30	84	John Lessiter, expense, superintendent and judge	$38 75	
					38 75

SWINE DEPARTMENT.

	30	34	L. W. Barnes, expenses, superintendent and judge	$24 30	
					24 30

POULTRY DEPARTMENT.

	30	70	C. A. Waldron, expenses, superintendent and judge	$28 05	
					28 05

FARM AND GARDEN DEPARTMENT.

	30	85	F. L. Reed, expenses, superintendent and judge	$34 85	
					34 85

DAIRY DEPARTMENT.

	29	32	M. J. Gard, expenses, superintendent and assistant	$28 95	
	30	97	A. H. Barber & Co., judge	20 00	
	30	111	J. M. Rankin, expenses, assistant	2 30	
Oct.	11	119	Crystal Springs Ice Co., ice	10 50	
					61 75

FARM IMPLEMENT DEPARTMENT.

Sept.	30	75	W. P. Custard, expenses, superintendent	$28 23	
	30	76	W. P. Custard, expenses, superintendent	7 25	
					35 18

VEHICLE DEPARTMENT.

Oct. 3	88	S. O. Bush, expenses, superintendent	$32 70	$32 70

MANUFACTURERS AND ART DEPARTMENT.

Sept. 30	61	F. E. Skeels, expenses, superintendent	$59 93	59 93

NEEDLEWORK DEPARTMENT.

30	60	Mrs. F. E. Skeels, expenses, superintendent	$31 54	31 54

HORTICULTURAL DEPARTMENT.

30	33	R. D. Graham, expenses, superintendent and judges	$51 25	51 25

MISCELLANEOUS DEPARTMENT.

30	77	John McKay, expenses, superintendent	$31 46	31 46

SCHOOL EXHIBIT DEPARTMENT.

May 16	23	Mrs. Lizzie Flynn, soliciting prizes	$16 00	
Sept. 30	72	Frank Maynard, expenses, superintendent	35 02	51 02

PRIVILEGE DEPARTMENT.

30	38	H. R. Dewey, expenses, superintendent	$44 77	
30	44	H. R. Dewey, superintendent, pay roll	120 38	165 15

GATE DEPARTMENT.

40	71	William Ball, superintendent, pay roll	$321 34	
30	73	William Ball, superintendent, expenses	20 15	341 49

POLICE DEPARTMENT.

30	39	E. W. Hardy, expense, superintendent	$25 15	
30	91	Chas. A. Coye, rent of cots	8 75	
30	104	E. W. Hardy, superintendent, pay roll	523 76	557 66

MARSHAL'S DEPARTMENT.

30	46	H. Whitcomb, assistant marshal	$15 00	15 00

MUSIC.

30	55	F. Wurzburg, band	$156 00	156 00

POSTAGE.

May 9	21	I. H. Butterfield, secretary, stamps	$15 00	
July 14	24	I. H. Butterfield, secretary, stamps	10 00	
Aug. 4	25	I. H. Butterfield, secretary, stamps	40 00	
Sept. 5	27	I. H. Butterfield, secretary, stamps	150 00	
30	52	I. H. Butterfield, secretary, stamps	95 00	
30	109	I. H. Butterfield, secretary, stamps	1 90	
30	115	I. H. Buttergeld, secretary, stamps and cards	24 00	
Oct. 11	124	Eugene Fifield, stamps	2 50	
1900. Feb. 19	146	C. W. Young, postage	11 31	349 71

PRINTING AND STATIONERY.

1899.				
Sept. 30	56	Powers, Tyson Printing Co., posters, blanks, etc.	$166 41	
30	94	Lyon, Beecher, Kymer & Palmer, stationery	4 15	
23	107	C. & J. Gregory, printing complimentary and other tickets	30 25	
30	123	Fair Publishing House, entry books, tickets, etc.	54 65	
1900.				
Feb. 19	143	Powers, Tyson Printing Co., stationery	7 25	
19	144	Calvert Lithograph Co., printing diplomas	12 50	
				$275 21

RIBBONS AND BADGES.

1899.				
Sept. 30	56	Powers, Tyson Printing Co., printing premium ribbons	$19 00	
Oct. 3	89	The Whitehead Hoag Co., badges for executive committee	49 50	
Sept. 30	99	Spring & Co., buttons, ribbons for premiums	37 25	
				105 75

TELEGRAPH, TELEPHONE, FREIGHT, EXPRESS.

July 14	24	I. H. Butterfield, secretary, express on stationery, cuts, etc	$4 80	
14	24	I. H. Butterfield, secretary, telegraph	2 88	
Sept. 30	54	I. H. Butterfield, secretary, telegraph and telephone	4 04	
30	54	I. H. Butterfield, secretary, express and freight, sundry	4 57	
30	101	I. H. Butterfield, secretary, express on advertising	11 28	
30	106	Western Union Telegraph Co., telegrams	15 07	
30	109	I. H. Butterfield, secretary, express paid	9 75	
Oct. 11	118	American Express Co., express bills	11 29	
11	124	Eugene Fifield, telegraph bills	7 34	
11	124	Eugene Fifield, express bills	2 35	
				73 37

ADVERTISING.

Aug. 1	26	C. B. Crisp, banner at fair	$10 00	
Sept. 30	40	Geo. S. Ward, services	60 00	
30	42	Geo. Greenway, street car banners	18 00	
30	47	Modern Woodmen, advertisement in program	10 00	
30	51	I. H. Butterfield, secretary, paid distributing bills	39 77	
30	54	I. H. Butterfield, secretary, sundry expenses	2 96	
30	56	Powers, Tyson Printing Co., posters, etc.	203 69	
30	67	Grand Rapids Herald, advertising	50 00	
30	89	The Whitehead Hoag Co., buttons	180 60	
30	90	Chas. A. Coye, banner over street	8 08	
30	92	Grand Rapids Lithograph Co., lithographs	160 00	
30	95	Geo. M. Leonard, bill posting	121 00	
30	98	Lawrence Publishing Co., advertisement in Michigan Farmer	35 00	
30	99	Spring & Co., cloth for banner	8 35	
30	105	Thos. Keyes, bill posting	61 10	
30	108	Kauffman & Strauss, book marks	110 00	
30	109	I. H. Butterfield, secretary, sundry services paid	69 19	
30	112	Michigan Fruit Grower, advertising	15 00	
Oct. 11	117	The Democrat, advertising	75 00	
11	120	Geo. M. Savage, list of papers, advertising	176 10	
11	121	D. S. Schram, advertising paper	12 00	
11	124	Eugene Fifield, advertising and address letters	13 50	
11	135	C. W. Young, treasurer, bill posting paid	59 38	
11	136	C. W. Young, treasurer, advertising bills paid	42 78	
11	137	C. W. Young, treasurer, advertising bills paid	80 05	
11	139	C. W. Young, treasurer, bill posting bills paid	53 68	
11	140	Grand Rapids Herald, balance advertising	25 00	
11	140	C. W. Young, treasurer, bills paid	30 50	
				1,730 73

			BUILDINGS AND GROUNDS.		
Sept.	30	35	West Michigan Agricultural Society, rent of grounds	$1,000 00	
	30	50	H. Hollis, cleaning grounds	7 50	
	30	57	Foster Stevens Co., sundries	17 90	
	30	58	C. B. Crisp & Co., one tent, cleaning art hall	37 00	
	21	62	Dorr Skeels, stakes and staking grounds	20 00	
	30	63	F. E. Skeels, superintendent, pay roll, workmen	305 93	
	30	91	Charles A. Coye, flags on buildings	33 00	
	30	96	J. C. Goss & Co., rent of tents	53 00	
	30	100	Chas. A. Coye, rent of tents	126 50	
	30	102	W. A. Stowe, paper for tables	9 33	
	30	111	Voight, Herpolsheimer & Co., decorating main building	133 35	
Oct.	11	127	Harry Hollis, cleaning grounds	32 50	
	11	130	F. E. Skeels, expenses and pay roll	107 07	
	11	138	John Rowson & Co., platform	94 50	
					$2,277 58
			GENERAL EXPENSE.		
Feb.	2	5	William Ball, expenses to Pontiac	$3 98	
Sept.	30	54	I. H. Butterfield, secretary, sundry small items	5 60	
	30	109	I. H. Butterfield, secretary, sundry small items	4 45	
	30	110	I. H. Butterfield, secretary, paid U. S. license	8 33	
	30	126	H. D. Plumb, straw	170 36	
Oct.	11	128	Modern Woodmen, percentage	150 00	
	11	131	Ira C. Barnes, services	10 00	
1900.					
Feb.	19	147	John A. Hoffman, services	12 00	
					364 72
			ATTRACTIONS.		
1899.					
May	11	22	I. H. Butterfield, expenses to Chicago	$16 82	
Sept.	29	30	R. Maretta, Little Edna, evening	184 00	
	30	36	Arthur Rose, bicycle	35 00	
	30	43	Ed. Smith, roller skating, evening	75 00	
	30	45	K. L. Butterfield, managing attractions	20 00	
	30	53	J. P. DeComas, aerial bicycle	200 00	
	30	58	C. B. Crisp & Co., painting signs	2 25	
	30	68	American Balloon Co., balloon	151 50	
	30	78	Sie Hassen, Ben Ali Arab troupe, evening	450 00	
	30	79	Fred Spoerhase, Nan Wilkes	300 00	
	30	80	F. E. Briggs, diving horses, etc	700 00	
	30	81	P. J. McCarthy, strong man	75 00	
	30	82	Jas. B. Macks, farmer comedy, evening	100 00	
	30	86	W. L. Vanola, bounding wire	250 00	
					2,559 57
			SUNDRY.		
Feb.	2	16	N. J. Kelsey, postage, 1897	$1 40	
	2	17	Eugene Fifield, expenses, business committee, 1898	16 98	
	2	18	I. H. Butterfield, expenses, business committee, 1898	17 46	
	2	19	Eugene Fifield, salary, chairman business committee, 1898	200 00	
	2	20	C. W. Young, treasurer, paid on 1892 premiums	85 12	
Oct.	11	133	C. W. Young, treasurer, treasurer's office, 1898	17 28	
	11	133	C. W. Young, treasurer, expenses on 1892 premiums	17 86	
1900.					
Feb.	19	145	I. H. Butterfield, secretary, sundry expenses	42 06	
					398 16
			Total		$14,885 57
Nov.	10	142	Order for treasurer to pay premiums		7,436 31
			Grand total		$22,321 88

Accepted and referred to the finance committee.

A recess was taken to 9 o'clock a. m., Wednesday, February 21.

WEDNESDAY, FEBRUARY 21.

Committee met at 9 o'clock a. m.

Executive superintendents submitted reports as follows:

REPORT OF SUPERINTENDENT OF CATTLE DEPARTMENT.

Gentlemen—As superintendent of Division A, cattle, I submit the following report of my department at the fair of 1899:

The total number of entries was 302, an increase of 83 over 1898. The quality of cattle shown was excellent, particularly in the Shorthorn, Hereford and Jersey classes.

I would suggest that the rules be changed, making stalls free, and that the exhibitor furnish straw for bedding.

(Signed) W. E. BOYDEN,
Superintendent.

REPORT OF THE SUPERINTENDENT OF HORSES.

Gentlemen of the Executive Committee:

I have the honor to report as superintendent of horses other than speed exhibited at the annual fair of 1899, that the exhibit was better than we have been favored with in recent years, but not to be compared with the annual exhibits of this department of ten or twelve years ago. The entries numbered 240, as against 219 in 1898. Many fine animals were shown. Exhibitors were well pleased with their treatment and with the awards of the judges.

(Signed) H. H. HINDS,
Superintendent.

SPEED DEPARTMENT.

To the Executive Committee:

The total offered in speed department was $3,450. The free-for-all class did not fill, and once "fourth money" was not drawn, leaving the total won and paid $3,120.

The amount received for entrance was $1,657.50, a difference of $1,462.50, which was covered in grand stand receipts due to races, privileges making net cost of races nothing to the society.

The attractions given between heats of races in front of grand stand were pleasing to the people and helped to fill the grand stand.

The races were good and were conducted in an orderly manner.

Respectfully submitted,

EUGENE FIFIELD,

Superintendent.

REPORT OF THE SUPERINTENDENT OF SHEEP.

Gentlemen—I submit my report for the exhibit of sheep at the fair of 1899 as follows: Number of entries in all classes 679, an increase of 283 over 1898, and probably the largest exhibit of sheep ever made in Michigan. The average quality was superior. A class for Horned Dorset was made for the first time this year, and a good exhibit was made of this breed.

Exhibitors were greatly crowded, but bore the inconvenience with patience.

Respectfully submitted,

(Signed) JOHN LESSITER,

Superintendent.

REPORT OF SUPERINTENDENT OF SWINE DEPARTMENT.

Gentlemen—The exhibit of swine at the fair of 1899 was a very creditable one, many very superior animals being shown.

General good feeling prevailed among exhibitors and much patience was exercised owing to the crowded condition of the pens for exhibition. The entries were 287, as against 338 in 1898.

Respectfully submitted,

L. W. BARNES,

Superintendent.

REPORT OF THE SUPERINTENDENT OF POULTRY.

Gentlemen—As superintendent of the poultry department, I report for the fair of 1899. The total of entries was 1,052, as against 889 in 1898, which crowded the accommodations greatly and made the work of judging onerous.

The quality of the exhibit was superior. The method of exhibiting single birds rather than pairs or trios gives entire satisfaction.

Respectfully submitted,

C. A. WALDRON,

Superintendent.

REPORT OF THE SUPERINTENDENT OF FARM AND GARDEN PRODUCTS.

Gentlemen—The exhibition in Division F at the fair of 1899 was about the same as that of former years, a fair display in the various lines of farm and garden products.

The judging was done by professors from the Agricultural College and gave universal satisfaction. The entries numbered 546, 92 more than in 1898.

Respectfully submitted,

F. L. REED,

Superintendent.

DAIRY, BEES AND HONEY.

Owing to infirmity and illness, the superintendent of this department was unable to report.

The premium list in the dairy class was enlarged and the awards made on a scale of points which gave all entries above a minimum total of points a share in the prizes. The result was a goodly number of entries and a good exhibit.

The awards were made by E. L. McAdams, of A. H. Barber & Co., Chicago. Special prizes offered by several manufacturers of dairy implements and salt, added greatly to the interest in awards.

I. H. BUTTERFIELD,

Secretary.

REPORT OF THE SUPERINTENDENT OF FARM IMPLEMENT DEPARTMENT.

Gentlemen—I have to report a large exhibit of fine goods in this department. All available space was occupied and exhibitors took great pains to arrange the ground, so they would make a fine showing. The best feeling prevailed among the exhibitors. In the farm fence class it was the largest ever made at the fair.

Respectfully,

W. P. CUSTARD,

Superintendent.

VEHICLES.

No report was made by the superintendent.

The exhibition was very large and of the best quality of manufactures. Over twenty large manufacturers were represented.

REPORT OF THE SUPERINTENDENT OF MANUFACTURED GOODS, PAINTINGS, DRAWINGS AND INDUSTRIAL ART.

Gentlemen—As superintendent of this department, I submit the following report for this department of the fair of 1899:

The entries in class 54, materials, were 9; in paintings and drawings, 123, and in industrial arts, 16; total, 148.

The quality of exhibits was superior and the decoration of the interior of the main building was exceptionally fine when placed in position, but were practically ruined by the fire communicated by electric wire.

The art exhibit was so large as to require nearly double the space usually assigned to that exhibit.

The Agricultural College was in the main building and proved a very interesting display. The testing of sugar beets, the showing of practical experiments, together with the exhibit of clovers, grasses and other material, serving to keep the space in front of the exhibit crowded with interested observers nearly the whole time.

Respectfully submitted,

F. E. SKEELS,

Superintendent.

NEEDLE WORK.

As superintendent of the needlework and children's department, I submit the following report for the fair of 1899:

The number of entries was 405, somewhat less than in 1898. The quality of the work was excellent. New ideas and designs are brought out each year, which necessitates changes in the premium list, but this can be made without increasing the amount, as some of the work discarded can be dropped.

Respectfully submitted,

MRS. F. E. SKEELS,

Superintendent.

MISCELLANEOUS DEPARTMENT.

Gentlemen—The total entries in this department were but 6. Nothing of any particular value in the way of new ideas, consequently I have little to report on.

Very respectfully,
JOHN McKAY,
Superintendent.

HORTICULTURAL DEPARTMENT.

Gentlemen—I submit the following report and recommendations for the horticultural department at the last fair:

The total number of entries was 467. Eighteen hundred and ninety-nine being an off year in some classes of fruits, the exhibit was not quite as full as usual, but the quality was good.

I recommend that the rules be changed to allow entries to be made on the first and second days of the fair in this department, and that the secretary assign a clerk for the purpose. In my experience it has been impossible for exhibitors to make their entries earlier. In consequence there has been great confusion and much trouble in getting the entry cards in the office of the secretary owing to the rush at that time.

I believe this change would obviate to some extent this trouble and not greatly increase the expense.

I also recommend that class 75 be changed and that the total money offered be given to an amateur class for plants and flowers, and that Prof. L. R. Taft be requested to prepare a suitable list.

Owing to the absence of an amateur list in this class, the whole exhibit has been by professional growers, to the detriment of the interests of the society.

Respectfully submitted,
R. D. GRAHAM,
Superintendent.

REPORT OF SUPERINTENDENT OF SPECIAL SCHOOL EXHIBIT.

Gentlemen—I submit the following as my report of the school exhibit at the last fair:

The exhibit of school work was large and creditable to the pupils and teachers of public and parochial schools and proved interesting and attractive to visitors. The galleries devoted to this work were crowded each day.

In the almost magical evolution of new ideas, and in the bewildering whirl of events which characterizes American progress, a department of the State Fair that brings out, classified for exhibition, the best product of school work, should not any longer be asked to beg from door to door for means to exist.

I recommend that it be made a permanent department with a regular list of prizes. A part of the list in Division O, children's work, might with propriety be transferred to this department.

Respectfully submitted,

FRANK MAYNARD,

Superintendent.

REPORT OF THE CHIEF MARSHAL.

Gentlemen—I submit the following report of the duties performed and the expense incurred in the chief marshal's department during the fair of 1899:

Your chief marshal was present personally, practically every hour, day and evening while the gates were open, and if any duties of an arbitrary character fell to the lot of the office I did not find them, and saw no occasion for interfering with any one for the enforcement of the rules. The expense of the department was but $15, for assistant, which included his whole expense.

Your chief marshal has the pleasure of reporting that in his observation there was a marked degree of satisfaction with both exhibitors and visitors, with the fair and its mangement, and had the weather been propitious there would no doubt have been a much larger attendance.

Very respectfully,

H. H. HINDS,

Chief Marshal.

REPORT OF THE SUPERINTENDENT OF POLICE.

Gentlemen—I submit the following report of this department of the last fair:

Good order was maintained throughout at an expense of $523.76. The attempt to hold evening exhibition increased the cost somewhat. The whole number of men employed was 49.

The society is under obligation to the police department of Grand Rapids for assistance, also to the sheriff of the county.

Respectfully,

E. W. HARDY,

Superintendent.

REPORT OF THE SUPERINTENDENT OF BOOTHS AND PRIVILEGES.

Gentlemen—I submit the following report of this department for the fair of 1899:

The receipts for the year for rents and privileges have been $2,918.13, which was paid over to the treasurer. The total expenses were $120.38, leaving a net balance of $2,787.75.

My thanks are due to the general superintendent, secretary and superintendent of main building for courtesies and assistance.

The extreme cold weather made receipts by renters light and in many cases collections were slow.

Respectfully,
H. R. DEWEY,
Superintendent.

On motion the reports of executive superintendents were referred to the committee on premium lists and the committee on rules.

The committee on president's address reported as follows:

REPORT OF THE COMMITTEE ON PRESIDENT'S ADDRESS.

Grand Rapids, Mich., February 20, 1900.

Mr. President and Gentlemen of the Michigan State Agricultural Society:

We wish to commend the president on his very able address and to mention the work done by Mr. Fifield and Mr. Dewey. The society are greatly indebted for their untiring efforts. The method of advertising adopted during the past year should be continued. His recommendation that the superintendents should be constantly in charge of their several departments, or notify the president of their absence, should be strictly observed.

That the time of holding the fair should, in your committee's judgment, be made as your president recommends—the second week in September. The variety of attractions which he recommends should be increased rather than decreased. Right here your committee think it would be well to suggest looking over carefully whether or not we should have night attractions, as the cost for attractions for the day will be no more if a night entertainment were also added. Wiring and poles for electric lights have been put in at a large expense, and the facilities for obtaining good lighting are such that they can be guaranteed beyond doubt to the society, as we are almost certain to have good weather at the time specified. The proposition would seem to us worthy of your consideration.

We would further recommend the advance payment for privileges be continued and the school exhibition be encouraged to the utmost extent.

Regarding transportation, we feel certain our railroads will continue to give us the same good treatment, and will go farther in anything we can reasonably ask if brought to their notice in a gentlemanly and business-like manner.

In conclusion, your committee wish to thank our president for his many suggestions, which are so helpful in arranging and conducting the fair, which this year will eclipse all preceding exhibitions.

R. D. GRAHAM,
H. H. HINDS,
L. J. RINDGE,
Committee.

The report was accepted and referred to the premium list committee, the committee on rules, and the committee of the whole.

The president appointed committee on premium list: W. E. Boyden, E. W. Hardy, John Lessiter, L. W. Barnes, F. L. Reed, Frank Maynard, John McGay. Committee on rules: Eugene Fifield, H. H. Hinds, D. Horton.

A recess was taken to meet at the call of the president.

Wednesday, February 21, 2 o'clock p. m.

Committee called to order by the president; same members present.

The premium list committee reported the premium list for the fair of 1900. A few minor changes were made from the list of 1899, and the school exhibit was made a regular department, to be known as Division S, and the superintendent was directed to prepare list and submit to the secretary for publication.

The report of the committee on premium list was adopted. See list as published for 1900.

The committee on rules reported a few changes in the rules. The report was adopted and the rules as adopted were printed in the premium list for 1900.

The finance committee reported as follows to the president and executive committee:

Gentlemen—The finance committee, to whom was referred the reports of the secretary, the business committee, and the treasurer, beg leave to report that we have with great care examined the books, stubs and orders drawn on the treasurer, and find his accounts as reported true and correct; also that we have with the same care examined the stubs, vouchers and report of the secretary, and find the accounts correct; also that we have with the same care examined the vouchers, orders and stubs relating to the statement of the business committee and find the report correct.

(Signed) H. R. DEWEY,
F. E. SKEELS,
JOHN McKAY,
Finance Committee.

The report was accepted and adopted.

On motion the date for the next fair was fixed for September 24, 25, 26, 27 and 28, 1900.

The place for holding the fair was left with the business committee.

The committee appointed at last meeting to suggest amendments to the constitution, to be presented to the society at its annual meeting for adoption, reported some suggested amendments.

The report was adopted and ordered referred to the meeting of the society to be held at the time of the annual fair.

FRANK MAYNARD,
H. H. HINDS,
WM. BALL,
Special Committee.

On motion the secretary was directed to send letters of regret of inability to attend the meeting on account of illness to Messrs. Ball, Gard and Cutting.

The election of general superintendent was taken up and Eugene Fifield was unanimously elected. H. H. Hinds was elected member of the business committee.

The president appointed the remainder of the standing committees and the executive superintendents, making the list as follows for the year 1900:

STANDING COMMITTEES AND EXECUTIVE SUPERINTENDENTS.

BUSINESS.
Eugene Fifield, H. H. Hinds and Secretary.

TRANSPORTATION.
L. J. Rindge, Eugene Jones, J. E. Rice.

PROGRAM.
Eugene Fifield, H. H. Hinds and Secretary.

PRINTING AND ADVERTISING.
I. H. Butterfield, Eugene Fifield, R. D. Graham.

RECEPTION.
S. O. Bush, L. J. Rindge, M. P. Anderson.

PREMIUM LIST.
W. E. Boyden, E. W. Hardy, John Lessiter, L. W. Barnes, F. L. Reed, Frank Maynard, John McKay.

RULES.
Eugene Fifield, H. H. Hinds, D. Horton.

FINANCE.
William Ball, F. E. Skeels, John McKay.

GENERAL SUPERINTENDENT.
Eugene Fifield.

CHIEF MARSHAL.
H. H. Hinds.

EXECUTIVE SUPERINTENDENTS.

Cattle—W. E. Boyden.
Horses, Speed—Eugene Fifield.
Horses, Roadsters, Draft and Pony Classes—H. H. Hinds.
Sheep—John Lessiter.
Swine—L. W. Barnes.
Poultry—C. A. Waldron.
Dairy, Bees and Honey—John McKay.
Farm and Garden Products—F. L. Reed.
Vehicles—Dexter Horton.
Agricultural Implements and Machinery—John A. Hoffman.
Manufactured Goods and Supt. of Main Building—F. E. Skeels.
Art—F. E. Skeels.
Needle Work and Children's Work—Mrs. F. E. Skeels.
School Exhibits—Frank Maynard.
Horticulture—R. D. Graham.
Gates—W. P. Custard.
Police—E. W. Hardy.
Forage—W. E. Boyden.
Booths and Privileges—H. R. Dewey.
Miscellaneous Exhibits—John McKay.

On motion adjourned to call of the president.

I. H. BUTTERFIELD,
Secretary.

M. A. C. ALUMNI REUNION.

JUNE 14-15, 1900.

ALUMNI DAY.

The triennial reunion of alumni and former students brought large numbers to the College from all parts of the country. Thursday was given up to the business meeting and the literary exercises of the Alumni Association, but many were here the previous day and attended the society reunions.

BUSINESS MEETING OF THE M. A. C. ALUMNI ASSOCIATION. JUNE 14, 1900.

The business meeting of the M. A. C. Alumni Association, held in the chemical laboratory, at 9 a. m., June 14, was called to order by President C. L. Bemis. The reading of the minutes of the last business meeting was omitted. In view of the fact that a portion of the minutes of former meetings had not been incorporated in the reports of those meetings, the secretary of the association was, on motion, instructed to compile all of the minutes, so that all of the transactions of the association would be on record.

The president appointed, as a committee on nominations, A. G. Gulley, W. O. Hedrick, James Throop, W. E. Hale and F. J. Niswander; and as a committee on resolutions, W. V. Sage, R. M. Slocum, D. J. Crosby, William Caldwell and G. C. Lawrence.

On motion, the members of the faculty were requested to meet with the association at their adjourned session.

On motion, the meeting adjourned until 3 o'clock p. m.

ADJOURNED SESSION.

Meeting called to order by President Bemis. The report of the committee on nominations was presented.

Your committee on nominations beg leave to submit the following report:

President—A. G. Gulley, '68.
First vice president—Louis A. Bregger, '88.
Second vice president—H. R. Parish, '95.
Secretary-treasurer—O. C. Howe, '83.
Orator—Liberty H. Bailey, '82.
Alternate—K. L. Butterfield, '91.
Historian—William J. Meyers, '90.
Alternate—C. H. Hilton, '00.
Poet—W. S. Holdsworth, '78.
Alternate—Jessie I. B. Baker, '90.
Necrologist—Prof. F. S. Kedzie, '77.
Alternate—Victor H. Lowe, '91.

A. G. GULLEY,
J. TROOP,
F. J. NISWANDER,
W. O. HEDRICK,
WILL E. HALE,
Committee.

On motion, the report was accepted and adopted.

Dr. Beal called attention to the desirability of having members of the alumni present ancient relics to the library for preservation. This was to include old books, manuscripts, programs, etc.

The committee on resolutions made their report:

RESOLUTIONS.

Whereas, It has been pleasing to the ruler of men's destinies to permit the alumni of the Michigan Agricultural College to meet again among these pleasant shades and noble temples of learning, the haunts of our pleasantest recollections, and the home of our affections, we do now most humbly express our thanks to Almighty God for his fostering care and preservation, and we do record our earnest prayer that He may ever lead the several members of our association and of the faculty of this institution into broader and better fields of life and experience, and that He may continue to lead, as he has always done, our alma mater vanguard of all these institutions which are, this day, solving the problem of American civil liberty and personal equality.

Inasmuch as we have been made young again, as it were, by this our visit to the dear old campus, to the class rooms and halls, and have been highly pleased and instructed by the exercises of this association; therefore be it

Resolved, That we extend our sincere thanks to our president, historian, orator, and necrologist, for the pleasure they have afforded us by their splendid addresses and papers; be it also

Resolved by this association, That we extend our thanks to the State Board of Agriculture and the faculty for the many courtesies shown us at the time of this meeting, and we wish further to commend the faculty and State Board for the wise changes made in the courses of study, and at the same time to make special mention of the excellent advantages provided for ladies at this College, all which it seems to your committee to have been warranted by the recent advancements in educational ideals and demands.

We who date our acquaintance with the Michigan Agricultural College to the early days of its existence among the educational institutions of Michigan, as well as those who followed later, have reason to hold in most happy remembrance the persons of two of the College faculty who meet with us today. We refer to Dr. Robert C. Kedzie and Dr. William J. Beal. To the able instruction and kind sympathy of these two members of the Michigan Agricultural Faculty much of the success and growth of the institution is due; and as alumni we hereby tender them our grateful thanks for all they have been to us and to the College.

Recognizing as we do the importance of giving attention to the physical development of the students of this College, and the impetus given to the same by properly directed athletics; and knowing the financial difficulties under which the athletic association of this College has always labored in not having an enclosed athletic field, where admission fees could be collected from all who enjoy the privileges of witnessing the games conducted by the association, we hereby urge the State Board of Agriculture to take the initiative in procuring such a field, and in this movement we pledge them our hearty and unqualified support.

W. V. SAGE,
WM. CALDWELL,
R. M. SLOCUM,
D. J. CROSBY,
G. C. LAWRENCE,
Committee.

The report was adopted by a rising vote. Mr. F. J. Niswander suggested that Dr. Kedzie, Dr. Beal and other members of the faculty favor the association with some remarks.

Dr. Kedzie briefly referred to the character of Edwin Willits and suggested that a bust in bronze would be very desirable, in order that it might be safely preserved.

C. B. Collingwood informed the association that the members of Iota Chapter of the Delta Tau Delta Fraternity were making preparations to perpetuate the bust of President Willits in bronze, the same to be mounted on a granite pedestal at some appropriate place on the grounds.

Dr. Beal spoke in regard to the better advantages afforded the students of today, as compared with those of a few years ago.

Dr. Edwards called attention to the security of such an institution as the Agricultural College, when supported so loyally, as it is, by the members of the alumni.

President Snyder preferred hearing what the alumni had to say, since the officers of the institution wished their honest criticism, that they might profit by it. Many members engaged in other lines of work might be able to offer suggestions which, if followed, would be advantageous to the institution.

Professor Smith spoke briefly in regard to his work among the farmers throughout the State.

Mr. Daniel Strange suggested the advisability of having a bust in bronze of President T. C. Abbot.

Short remarks were also made by M. D. Chatterton, John E. Taylor, John I. Breck and J. D. Towar.

On motion the meeting adjourned.

O. C. HOWE, Secretary.

ALUMNI LITERARY EXERCISES.

At the close of the first business meeting, the alumni assembled in the chapel for the literary exercises. The program included addresses by the president and historian, the oration and the necrology, and closed with the presentation of a bust of President Willits by Prof. P. M. Chamberlain, '88, in behalf of the members of the Delta Tau Delta Fraternity. The session was enlivened with songs by the Mozart quartette—F. W. Cowley, with '93, Gage Christopher, with '93, C. S. Joslyn and L. B. Tompkins.

PRESIDENT'S ADDRESS.

THE HIGHER EDUCATION OF FARMERS' CHILDREN.

CHARLES L. BEMIS, '74.

This is the last meeting of this association for this century. We, like the century, are passing away; but these meetings will continue as long as this institution exists, and I can see no reason why it should not exist, and under greater fortune than now, for centuries to come.

We were all born in this century and received our education in its last half. Our Alma Mater was born in this century and stands today the oldest agricultural college in the United States. Not only is she the oldest, but from the establishment of similar institutions in this country she has stood at the head and is the one after which all the others have patterned.

At the beginning of this century there were no specific efforts made to educate farmers. It came in as a subordinate study in other schools much as bookkeeping or a commercial course now does. It was thought that anyone could be a farmer, that it required no culture and no ability to think beyond the merest routine of planting seeds and gathering the harvest.

Why should farmers be educated? This question I have often asked myself and have as often been asked it of others. It is urged that farmers are only tillers of the soil and as such require no education. For one to make such a statement argues ignorance of facts on his part, or carelessness or wilfulness in not giving the subject sufficient thought to come to a reasonable conclusion.

A farmer's occupation has to do with things in such a way as to make it a complex problem, involving a knowledge of all the sciences that result from the study of the various phases of nature. Hence, to understand the underlying principles of their occupation they must be more or less familiar with all these sciences. In many cases these sciences involve an understanding of mathematics far beyond a mere knowledge of arithmetic.

Agriculture is the basis of "bread and butter getting" for the entire nation. We could do without the merchant and the manufacturer. It has been done in the past. They are simply conveniences. They are conveniences, however, that we do not wish to do without. All business is dependent upon agriculture.

The relation that the farmer has to those about him makes it necessary for him to know history, civics and economics. In fact, all those subjects that help him to understand his relation to his fellows, to society, and to the state, are of the greatest importance to him.

In looking over the representatives to the State legislature for the last session, I find that about 40 per cent of them were farmers. In order to be of any benefit in this day of thought, it is necessary that they understand the above mentioned subjects. Without them they could act their part only as followers, and be subordinate to men in other occupations and professions; with them they would be subordinate to no one, but could act as leaders or intelligent co-workers with any leader.

If the necessity for educated farmers exists, and I believe it does, the farmer's education should be as thorough as that of any man's in any occupation or profession. At the University of Michigan the time required for a lawyer or a physician to get his degree is now six years; and this, too, after having four years in a high school. I shall take it for granted, then, that the farmer's education should be thorough, and as bread as that of any man's in any other profession or occupation.

The point I wish to make is that to reach this culture it is necessary to have a better preparation than possessed by most of the candidates for admission to agricultural colleges.

I think that most men who have not had a college training consider education as consisting of a knowledge only of those subjects absolutely necessary in "bread and butter getting." The knowledge of other subjects that give breadth to the mind and make the individual an "all round man" are looked at as giving a polish that is only an ornament and of little or no value. These objections are so general among men that we might say that they are almost universal. Such a narrow notion it seems to me should be corrected.

A young man entering college went to see the president and to make arrangements as to his course of study. The president pointed out a line of work that he thought would meet the young man's capacity and urged him to take it. Seeing a hesitation, the president asked the cause. The course of study was objected to because it was too long. He could not put so much time into a preparation for his life work. The president then asked, "How long do you expect to live?" The answer was, "To be about eighty years old." "Very well," said the president, "if that is as long as you expect to live the shortest course

you can take will be too long. My idea of a preparation for life's work is that which prepares for eternity. I am preparing to live forever."

The story illustrates the fact that there is a feeling among young men that they must begin to earn money at a very early age, and that they do not understand that the best kind of preparation enables them to do in after life what they have to do with greater ease and with more satisfaction to themselves; and that they are capable of doing a greater amount of good in the world during their active period. In other words their ideas are selfish. The benefit to the world at large is entirely foreign to their idea of things.

To make the representative farmer what representative men in other occupations are, he needs the same preparation and the same wealth of mind or mental strength. To get this it requires a foundation, years of mental exercise and growth.

It seems to me that as graduates of this College, we should all be interested in its future, its prosperity, and the quality and number of its graduates. We should also be loyal to the institution, to its faculty, and to the board.

I believe in giving the faculty of the College the entire management of the course of study and the methods and manner of teaching various subjects, holding them responsible only for results in the education of the pupils, and standing by them in everything that they do unless results are defective.

The same with the Board, what they do is expected to be for the best interests of the College. We may not always understand, but if the results of their managemnt are all that they should be, we should stand by them in everything.

The College today is strong, strong in all its departments, and the president and his faculty are doing all that any man or body of men can do to keep it so, and to make it a great factor in the agriculture of this country.

Young men and women from every part of the State, from various states in the Union, and from different nations in the world, are coming in flocks every year, for the benefit to be derived from contact with its professors, and the inspiration from the atmosphere of the institution.

Seeing the results to be what they are, all of us should do what we can, by our influence in the part of the country in which we live, to secure a healthful feeling where it may not exist, and to strengthen the feeling where a good feeling is in the atmosphere. The higher education of farmers' sons and daughters should be encouraged, and a better preparation for admission should be urged upon every pupil who seeks admission. I know that the professors would rather teach a well prepared pupil than one who is poorly prepared, and I know those best prepared to enter will make the best graduates, and the ablest and most influential members of the society in which they live.

This being the close of the century, and for the college the close of a well rounded period of influence and amount of good done in the world, why not begin the next century by requiring a higher standard for admissions. Taking the lead in this direction will be doing only what the College has done along other lines of work.

It seems to me that for the present, at least, the work of the College could be divided into various sections, designated by some appropriate

name and leading on to more or less proficiency along certain lines of work, the completion of which would lead to no degree, but in themselves be of such a nature the taking of which might diminish the labor required to do the complete course, if the pupil wished to take it; and in any case to lay a foundation for future study. The divisions might be made to include an amount of time covering one or two years. Into these divisions those having the minimum requirements could enter and acquire some higher notions of agriculture. Now if these do not work for a degree they go away with the spirit of the institution implanted in them and become much stronger men than without this contact with the institution.

On the other hand, the course of study that leads to a degree should be of a much higher type, embracing perhaps the others, but requiring the maximum qualifications for entrance, and leading up to a well rounded knowledge of scientific agriculture, ending with a diploma and a degree. The same qualification for admission could be required for all the other courses leading to a degree. Something like this has been done by normal schools and it has worked well. I can see no reason why it would not work well in an agricultural college.

By some such arrangement, all classes of students could be accommodated and benefited. The student taking the complete course would be a much stronger man.

What I have said has, perhaps, been too short, with too few illustrations, and in too disconnected a manner, to make what I want to say clear to those who have not given it much thought. The higher education of farmers' sons and daughters is a subject to which I am particularly interested, and the method of getting at it I have tried to outline.

The Agricultural College is the institution that is to accomplish that work, and we are the ones to support her. As for me, my influence shall always be directed to that end.

HISTORY, FOR TRIENNIAL REUNION OF M. A. C. ALUMNI ASSOCIATION, 1900.

LUTHER H. BAKER, '93.

The exact scope, both intensive and extensive, of a history of the Alumni Association has been a quandary in my mind ever since the misguided action of the last "Triennial" in selecting a historian for 1900. Dr. Beal's painstaking and accurate catalog of officers and graduates, giving the address and occupation of each alumnus up to 1895, renders the usual species of alumni history unnecessary. On the other hand, every loyal alumnus,—and only such are present today,—is perfectly familiar with the facts in the history of the College. Confronted thus by a hopeless dilemma, and not caring to take either horn, I have endeavored to adopt a course independent of either. The educational trend of the College, as observed in the various periods of its history, furnishes such a course, and has been adopted as the most feasible and profitable.

In all ages and among every people, the history of institutions has been marked by epochs moulded by some strong personality, or influenced by the development of new conditions. The Michigan Agricultural College, far from being an exception, furnishes a most typical and interesting example of this truth.

In general, there are three distinct periods in the history of our Alma Mater, which may be designated, for lack of better terms, as the Abbot period, the Willits period, and the period through which the institution is now passing, which may be known to future alumni as the Snyder period.

The first of these, characterized at its start by woods and stump fields, isolation and poor equipment, hard work and few tangible results, saw our agricultural course fully inaugurated, vindicated, and established before the people of Michigan. When, in 1883, President Abbot resigned the post which he had for twenty years filled with such honor to himself and the College, the formative period of the College was well passed.

The second period, marked by the establishment of our mechanical course, largely through the energy and perseverance of President Willits, extended through the presidency of Doctor Clute, a period of ten years. During this time the educational trend of the College deviated decidedly from the original course contemplated at its inception. A few scattered quotations from President Abbot's exposition of the objects of the institution, found in the catalog of 1863, will make my meaning plain. He says, "The State Agricultural College proposes:

"First, To impart a knowledge of science, and its application to the arts, especially those sciences which relate to agriculture and kindred arts, such as chemistry, botany, zoology, and animal physiology.

"Second, To afford its students the privilege of daily manual labor.

"Third, To prosecute experiments for the promotion of agriculture.

"Fourth, To furnish instruction in the military art.

"Fifth, To afford the means of a general education to the farming class."

From the clearly stated propositions it appears that the only constituency which the College possessed or desired previous to the Willits' period, was the farming class. Strong as this class is and has always been, it still furnishes but one source of patronage for the institution to draw upon. Every business man knows that the surest income is that which is derived from a variety of independent sources; and this truth, translated into educational terms, was adopted as the guiding principle of the College when the mechanical course was inaugurated. Recent statistics how that the rural population of many sections of Michigan is actually decreasing, while that of the cities is increasing. This indicates, among many other things not pertinent to our history, that there is a growing industrial or mechanical class, while the class upon which the College had heretofore placed its entire dependence for moral support is actually decreasing in numbers. Without stopping to analyze this situation farther, let it be said that that institution is the strongest which anticipates the demand of the time; whose guiding spirits are in touch with the people from whom its support and patronage must come. Nothing but the highest praise can therefore be given to our State Board of Agriculture, who, before the present industrial conditions had

become clearly manifest, penetrated deeply enough into the problem of education for the masses to anticipate this demand for a thoroughly practical course in mechanics, and to provide laboratories, shops and competent instructors to place it within the reach of all.

The evolution of an institution is, in many essential respects, like that of society. Henry Drummond, in his "Ascent of Man," states a principle which has come to be known as his key to special progress. He says: "It cannot be that the full program for the perfect world lies in the imperfect part. Nor can it be that science can find the end in the beginning, get moral out of non-moral states, evolve human societies out of ant heaps, or philanthropies out of protoplasm. But in every beginning we get a beginning of an end; in every process a key to the single step to be taken next." The introduction of our mechanical course was thus of greater importance as an epoch marker than any other single event in the history of the College since its establishment, inasmuch as in this "process" we see a key to the "single step to be taken next." In the subsequent establishment of the Women's Department we see but another step in the recognition of the truth that henceforward the Michigan Agricultural College must stand for the education of the whole mass of people.

From that moment, when the definition of a patron of the M. A. C. was changed from "farmer" to "bread winner," the pyramid of its fortunes no longer stood upon its apex, but on the broad base of popular support and popular approval. How logical, then, was the next step taken by our beloved Alma Mater, and yet how foreign to the minds of those most active in securing for us the mechanical course; for the women of our land—silent, patient toilers, rendering bright our firesides and constituting the factor without which the word home would lose all its sacred significance, are they not entitled to recognition as bread winners? Constituting as they do half the population of the land, wielding an influence over the characters which are to mould the destiny of our nation, beside which all other influences are insignificant, should they not receive the best that there is in the way of broadening and refining influences of music, literature and art? Our State Board of Agriculture again demonstrated its grasp on the educational problems of the day by anticipating the demand for an education for woman as practical as that demanded by man.

Thus in a three-fold way, our College touches the everyday needs of the masses. It can, in no sense, be called a class college. It represents no sect, no creed, no party, no caste, but in the broadest sense of the word it stands for all.

Nor has this increase in the scope of the College meant a decrease of its usefulness in the direction originally intended. It is more than ever a college for the farmer. By the addition of short courses in dairying and sugar beet raising, by its special attention to the problems of sheep husbandry and stock breeding, and by the splendid services which our horticultural department is rendering to the market gardener and the fruit raiser, the Agricultural College is coming to be more and more a practical necessity to those producers of all wealth, the tillers of the soil.

Am I hasty in saying then, in view of these facts, that the Michigan Agricultural College occupies a unique place among the educational

institutions of our State? While the denominational colleges represent their special sects; while the State Normal School exists for the education and training of a certain class, and for that alone; while the University itself stands for higher literary and professional training to which few indeed of the masses can hope to attain, the M. A. C. can truthfully be said to represent the best and highest interests of every bread winner within this great commonwealth. It does not surround itself with a high wall of entrance requirements; it places the highest possible value on the clear head, the willing heart, and the steady hand; it recognizes the eternal truth that manual training and mental development must go hand in hand.

Is it to be wondered at, then, that we are proud—justly proud, of our Alma Mater? Not alone because of her splendid equipment and beautiful grounds, nor yet of the brilliant array of well known men of science who have taught within her walls or who have gone out to other colleges and universities; but because she stands with open arms to welcome to her halls of learning, to her laboratories, to her workshops and to her farm the sons and daughters of the great middle class; that army which constitutes the bone and sinew of our country; which does its work and produces its wealth; which protects it alike from internal danger and from foreign foe; which constitutes the great stratum between the foam and the dregs on which the hope of the nation and the race depends. As a function of this all-powerful factor in the problem of our national life, the Michigan Agricultural College may look with confidence into the future, and be assured of glorious things.

ALUMNI ORATION.

The orator for the occasion was W. K. Clute, '86, of Ionia, who spoke on "The Value of Ambition."

Mr. President, Members of the Alumni Association and Friends:

My sincere pleasure in meeting here today so many of the alumni and friends of the College I have no doubt is the common sentiment of all.

It will not be my purpose to regale you with any of the flowers of rhetoric, but simply pluck a few grasses and present them to you, hoping they will not be too green and that they will remain fragrant in your memory. The general expectation of so numerous and respectable an audience at a college of the renown of this one naturally produces a feeling of such diffidence and apprehension in him who now has the honor to address you, and he therefore craves the indulgence of friends while he submits a few thoughts upon "The Value of Ambition."

A quality which demonstrates itself as having much to do with all truly great and successful persons or nations is ambition. Combined with other qualities which are possessed by all, it produces marvelous results. Its proper cultivation is the improvement of the human race.

Ambition is a passion and must be controlled. To attain coveted positions, candidates for fame and fortune too frequently abandon the

plodding paths of virtuous labor for the quicker and corrupt roads to glory.

In politics, often, candidates for our high offices seem to be above the law, and if they can, by the judicious (?) use of money corrupt the caucuses and conventions as well as the ballot box, thereby attaining the object of their ambition, they have no fears of being called to account for the means by which they were elected. They often endeavor by fraud, bribery and falsehood (the ordinary and vulgar arts of intrigue and duplicity), or by crimes of the most enormous character, to supplant and destroy those obstacles which stand in the way of their desires for gain and greatness. It is fortunate, however, that they more frequently miscarry than succeed, and commonly gain nothing but the distrust of their fellow citizens and the punishment awaiting them when pursued by the hand of justice.

The low estimate put upon the value of personal ambition in the desire for holding as well as the faithful discharge of the sacred trust of a public office is manifest to our people by the unhappy coincidence that seven of our heretofore prominent public State officials stand indicted, one of whom is convicted and six still awaiting trial for conspiracy, robbing the public treasury, or else giving or accepting bribes to do the bidding of private interests in the legislative halls. The people of our State will maintain their usual self poise and presume all the untried parties not guilty until the proven facts show otherwise, at the same time the people have a perfect right,—nay, it is their duty,—to demand the unrelenting prosecution of these cases in order that every guilty one may meet condign punishment, and that examples of what will follow malfeasance in office be set before others. Our public officials should be given emphatic notice that it is just as criminal to steal from the public treasury by fraud in office as it is to crack a bank safe in the night, and that prosecution will be as certain in one case as the other.

Another apt illustration of misguided personal and political ambition is shown in the career of Napoleon the Great. This extraordinary man, dreaming of universal empire, superstitiously believed that fate intended him to hold Europe in his hand. But we can see that he was designed by that remorseless fate for a very different purpose, and a very brief office. He was the terrible instrument which she intended to use for one specific purpose only and then to cast aside. This work was the destruction of the Roman-Germanic Empire. That lifeless mass, whose oppressive weight had crushed the life and hope out of Central Europe for centuries, needed some tremendous force from without to break up its time encrusted rivets. And that force was in the hands of a workman who supposed he was rearing a great edifice for himself.

Napoleon, in fact, entered upon the most daring scheme ever attempted in Europe; to convert the whole continent into one vast empire with the kings and princes over the several nations all subject to him.

His career was a grand one while he was engaged in crushing out the superstitious customs of the ancient church that held the nations of Europe in his grasp, but when that was ended and he still continued on the march for unworthy personal ends, the fate that had picked him up, flung him aside. He learned it too late. History holds no picture

more powerfully impressive than that of this man waiting at Fontainebleau, twelve leagues from Paris, still believing in his power to retrieve, and unconscious that he was already deposed.

The contrast between this great European military despot and the greatest American military genius of modern times so familiar to us, our own Gen. U. S. Grant, shows the difference between unbridled ambition for power on the one hand, and an inspiration to benefit one's fellow men on the other.

Napoleon fought to add greater lustre to his own name and his own imperial glory in the downfall of the vanquished, while General Grant waged his battles to compel his enemies to submit to the doctrine that all men are created equal. When Lee surrendered at Appomatox, Grant not only graciously declined to receive his sword, but, upon learning that the conquered army was on the point of starvation, ordered a division of the rations of the Union troops with the soldiers of General Lee's army; and told the Southern cavalry to take their horses home with them as they would be needed to cultivate their fields. Napoleon's career shows us a masterpiece of supreme, vain-glorious selfishness, while General Grant is a fitting type of a well balanced man with a laudable ambition to serve his country well, and our nation is glorified thereby.

A nation's glory is the fruit of the civilization of its people. The character of national life is made up of the sums of the characters of its citizens. If the spirit which pervades our nation becomes dulled and morbid, it will be because our people have become so. It is essential to the virility of our nation that the temperament of our people be kept in a healthy condition.

"Ambition is a spirit in the world,
"That causes all the ebbs and flows of nations,
"Keeps mankind sweet by action," says Crown.

The laudable ambition of every nation should cause it to make its laws observed without fear, favor or affection, both by the rich and the poor. Its courts, the sturdy bulwarks of individual liberty, must be reputed for their fairness and integrity among the people at large.

It remains for our courts, both federal and state, to hold back an often capricious and sometimes inflamed public opinion, aggravated by the railings of factious leaders of the populace, from committing those dangerous trespasses against the sacred time-honored rights of a free people which, in the lucid periods that follow, would be sincerely regretted had the intended results been fully accomplished. Holding as they do neither the sword nor the purse, no matter how violently the pendulum of public opinion may swing to the right or left, they will as the third co-ordinate and independent branch of our government remain the trusted public custodians of our people's conscience.

A state or nation's legislative halls should be free from the reproach of bowing the knee to Baal or worshipping the God Moloch. The money of its people, which is the life blood of a nation, must be pure and constant in quality. It must be free from a suspicion, even, of being tainted or corrupt.

A nation ambitious to be just and great must labor for the happiness and freedom of its masses. To advance the freedom and contentment

of its people it must do all in its power to promote the widest diffusion of education, especially among the youth. The money of a people that is spent in the establishment of public schools, colleges, universities and free public libraries is the best investment it makes of any character.

Notwithstanding all our modern advantages, there are at work, in our body politic, influences having a tendency in the opinion of many to depress the virility of our people.

We are living in a progressive age. Individuality, apparently, is becoming submerged in a general mass. The growth of the corporate idea, which some call revolution and others evolution, has a strong tendency to make man seem a part of a machine, rather than to develop in him a distinct and separate existence. The invention of the cotton gin, the loom, the application of steam to the means of public transit, both on land and water, and to manufacturing generally, the telegraph and the telephone, and the new and useful applications of electricity to the comforts and luxuries of the people, together with all the inventions for the cheapening of labor and lessening the cost of the production of products of all kinds, has brought about a change that has tended to the blending of man into so small a part of our industrial society that his individuality is well nigh submerged. The change is certainly one of evolution, and a little comparison will show that we are outstripping our ancestors in bringing within easy reach the substantial necessities, comforts and enjoyments of life, that they had to struggle long and hard to obtain. If they can be more evenly distributed, so that more of our people may enjoy their benefits, all of these signs will be hopeful and reassuring.

But, as if to pre-empt for the use and profit of a few, all of these things which should be the heritage of the many, a creature called a corporation has come upon the scene and embraces the great properties like railroads, telegraphs, telephones, coal and oil fields, steamboat lines, mining industries, and all of their kind down to the smallest private enterprises. Our retail stores, bake shops, shoemakers, ice wagons, the practice of law, even, in fact, almost every kind of business, is now masking itself under corporate impersonality.

Take the leather industry for an example. Instead of a man being the maker of a whole boot, he will simply act perhaps as a pegger, or a stitcher, or a tip maker, or a seam maker, and so on to every part of a complete shoe. The trade of making a whole shoe is lost. A man who does nothing but operate a peg driving machine all his life, utterly unconscious of what was done before him and of what will follow, certainly will have but little incentive to stimulate his feeling of independence and interest in the business of his employer. He is simply an automatum. And this same idea goes through all the modern industries.

Individual ambition under such influences is stunted, for there is no field for its exercise. Such a man's only object is to please his master and this is the antithesis of a healthy personality.

If it be true on the other hand, however, as it is asserted, that the promotion of this class of corporate life and activity secures more contentment, steadier employment to the laborer and average business man at regular wages, shorter hours and consequently more leisure for rest, study or recreation, lower prices for what the people have to buy,

and better prices for what they have to sell, as well as a greater capacity for the extension of our trade and commerce with the world at large, then they are not an unwelcome accession to our social order, but represent the refined and finished product of modern, social and industrial evolution.

There are two worthy ends which every individual should be encouraged by his government in attaining. First, to own a home; second, to own an independent business. It can safely be said that the larger the number of our people who are enjoying these two blessings, the more generally contented, independent and happy will we be.

It is not my purpose, nor is this the place, to consider any academic inquiry into the social problems of the day, but it occurs to me as a suggestion which I wish to throw out to you educated men and women whether or not the present rapid rush towards the indiscriminate organization of commercial power, into single highly capitalized corporations for the transaction of nearly every kind of business, is not a serious menace to the ambition of the humble masses of our people and hence to the prosperity of our nation.

Is it well that individual man should become bound up like the wheels and shafts of a great factory, each dependent upon some connecting part of a machine, and the whole controlled by the will of one master? Do these huge aggregations of capital advance or retard individual wealth and happiness among the greatest number of our people? Do they not often tend to crush out the moral courage as well as destroy the business of the individual producer, merchant and manufacturer?

Ever since commercial trusts were held illegal by the United States Supreme Court, capital has slipped the noose and accomplished the same results by organizing as private or quasi public corporations under the laws of some one of our states of identically the same kind that have been created and favored all over our nation for the last half century.

With this artificial entity as a nucleus, an accretion of capital sets in, eventually bringing about a great consolidation of business interests. Thus by a legal circumvention of the trust plan, the radical idea for a union of forces is worked out that is equally effective to accomplish every result which in reality made the trusts illegal. A little legerdemain turned the trick. It is presto, change! Now you see it, and now you don't.

Their object is to exercise artificial rights and privileges not possessed by the individual. They receive their breath of life by force of state statutes. The primary legal idea of corporations is that they combine the capital, talents and skill of many individuals in one pursuit and seek to secure for the stockholders advantages which none of them can gain single handed.

The public utility of these modern consolidated groups of corporations, sometimes called judicious combinations, but misnamed trusts, is now being questioned. When once born and set on their feet they have the world before them for their field of labor, and the question will arise in giving our federal government control over them, if that is the remedy, whether or not the people of the states wish to surrender to the federal government another very large portion of their sovereign

power, over a subject which has heretofore been in the state's exclusive control.

A corporation cannot be confined in its operations within a state line. The right to free commerce between states prevents that. Their present method of operation is to become chartered under the laws of some state with liberal provisions as to their duration, capitalization and object of incorporation. Their scheme embodies farther this idea: That the stock therein be issued to the owners of practically all the small corporations or companies in any particular line of business, in one or perhaps several or all of the states, in consideration of the property, good will and business of the smaller concerns in the combination all passing to the new organization, and by these means one whole industry, or a series of industries, becomes merged into one giant feudal corporation.

Thus is formed a combination of capital, skill and power in business that has the controlling financial and commercial strength of a giant. The individual, therefore, must compete practically with a business monarchy. It has a distinct head and everyone beneath is in a condition of servile dependence. Their methods frequently throttle fair competition by their unduly engrossing and forestalling the market on many lines of products. Their organization frequently closes, without good cause, numerous industries in different parts of the country that had previously been doing a thriving business, and thereby throw labor out of employment. They put down prices of goods in one place below the legitimate cost of production to drive a rival out, and raise the price of their wares in another locality to make their accounts on the deal balance.

They wield the boycott, the bludgeon of trade and commerce, with tremendous influence, by refusing to sell their wares to a man who buys of a rival at the same time he seeks to deal with them. All of these things they have done and now do for the avowed purpose of stifling legitimate competition.

We should not forget, however, in treating of this question, that a man has a right to buy and sell as he pleases; so has a corporation. A man has a right to indefinitely extend his business and holdings. Is this right to be curtailed as to corporations when exercised within their legal objects? Have not corporations, the same as the individual, a right to use new and improved methods in business, the patents, inventions and every other device known to the arts of trade and commerce for the cheapening in production and distribution, as well as the betterment of the manufactured article? All will concede that they have this right.

Are we, however, ready to concede that a comparatively few men of great wealth may form and operate without limit this business machine that works to the detriment, as many believe, of so many individuals? Is it good for the body politic that a few should be the masters of our country's trade, manufacturing and commerce and so many their servants?

These institutions do not possess the vested right to lead this kind of a life. The present concentration and ownership of nine-tenths of all the country's personal property into the control of corporate life

is no more to be desired than would be the accumulation of vast landed estates into the hands of a few land barons. This relic of the feudal system has been abolished in every state of the union, I believe, by repealing the law of primogeniture, so our lands are owned in a broad sense in small holdings with the occupant not a tenant, but the possessor of an allodial estate.

Feudalism, in its palmy days, meant that all the land, air and water, with the beasts, birds, fishes and minerals, belonged not to the people, but to the lords of the soil. If a man wished to fish, hunt, shoot a bird in the air, gather sticks, pluck a twig, leaf or fruit from the trees, or pick up anything from the ground, he must first get permission from the lord of the manor, or some of his underlings. This meant that the weak were to get weaker and the strong stronger, and the cunning more cunning. The time was, under the feudal system, when man passed with a deed of the land as a part and parcel thereof, the same almost as animals in the forest. Is there no parallel between some features of the feudal system and the system of corporate development that takes in our industrial society today?

Judging by analogy in the light of history would it not be beneficial to the individual if the concentration of so much artificial power and wealth in a corporate entity were reasonably checked? If the value of individual ambition is to count in the scale, the state owes it to its people to inquire carefully into the use of the franchises it has granted to some of our citizens.

Whatever the evils may be in such corporations, they must be regulated and restrained as are the rights of the individual, not seeking to work destruction, but observing at all times the natural laws of trade which will take care of themselves in spite of all the legislatures in Christendom.

If these corporations are a menace to the individual, they are a menace to the nation; and it is our duty to begin to correct their errors at the points where they defiantly over-ride the law or prostitute the purpose of our government to their private ends. Every corporation is a creature of the people, brought into existence by their state legislatures, just as much as our national banks are creatures of congress, and one should be just as much subject to public scrutiny as the other.

The power of the people to deal with the problem as they see fit is not doubtful. Judge Cooley, in an early Michigan case, said this:

"The sovereign police power which the State possesses is to be exercised only for the general public welfare, but it reaches to every person, to every kind of business, to every species of property within the commonwealth. The conduct of every individual and the use of all property and of all rights is regulated by it, to any extent found necessary for the preservation of the public order and also for the protection of the private rights of one individual against encroachment by others."

This great Michigan jurist, whose fame as an authority in legal jurisprudence has extended all over our land and even to Great Britain and continental Europe, has, I believe, touched the keynote of the power of the people on this subject in the language I have quoted.

The demagogue and quack statesman, who unjustly denounces all forms of corporate life and usefulness, as well as the schemer who selfishly misuses it, ought to stand together and share the public cen-

sure. The good in it should be retained and the evil expunged in order that the lawful ambitions and opportunities of many of our people shall not be crushed by the unjust methods of these institutions.

Fellow graduates, I conjure you to stand by the individual in the social struggles that are going on. Keep within his reach the incentive for activity, for education and for commerce, the development of the liberal arts and all that goes to make up a free and active man. Fight against socialism because it enslaves the masses and brings all men to a dead level; the lightning of genius never strikes a dead level; it only hits points.

The value of individual ambition is too great to be sacrificed to the commercial demands of the age. Ambition ruled by reason and religion is a virtue. Unchecked and maddened by vanity, avarice and covetousness, it is a vice. Ambition is opposed to communism. "Every round in the ladder of fame, from the one that rests on the ground to the last one that leans against the shining summit of human ambition, belongs to the foot that gets on it." It believes in every man striving for what he has. "In the intellectual world, it says to every man, let your soul be like an eagle. Fly out into the great dome of thought and learn the truth for yourselves." No man could ever rise in his profession, trade, or occupation having no ambition to reach its higher points. Like every other gift, it is the abuse and not the use of ambition's fire that leads to erring. Kept within proper bounds it is a noble quality leading to perfection.

REPORT OF THE NECROLOGIST.

MRS. P. B. WOODWORTH, '93, CHICAGO, ILLINOIS.

Fellow Alumni and Friends:

Again have three years rolled away and we gather here to renew once more the happy memories and associations of our College days and to wander, as of yore, about its ever beautiful campus. With the happiness there also comes a tinge of sadness, for always as we look the faces over and inquire for all the dear old friends do we find vacancies in our ranks which will never more be filled. And so it is but fitting that, as we come together again, mention should be made of those whom the Angel of Death has visited and taken under the shadow of his wing. This task, hard for any of us, seems doubly so to me, for so closely has my life been interwoven with the life of the College that the death of any alumnus is in almost all cases the loss of a personal friend; and it is with heavy heart that I look the list over. Since our last meeting twelve of our number have answered the last roll call and gone to their eternal rest. But we thank God that the lives were true and useful and that the memories which they have left behind are dear and honored ones. Their usefulness could not end in death, for always will their example be felt as an influence for the good. In several cases have the deaths come from lingering and incurable diseases, and these have been borne in a spirit of greatest cheerfulness and resignation.

"We must all die!
All leave ourselves, it matters not where, when,
Nor how, so we die well; and can that man that does so,
Need lamentations for him?"

Words are but empty comfort and we cannot express our sorrow for those who have been bereaved, but may it be some consolation to them to know that the hearts of the College friends go out to them in sympathy.

IN MEMORIAM OF

Charles E. Hollister, of the class of '61, who died at his home in Laingsburg, Mich., on the 11th of April, 1900. Mr. Hollister was a member of the first class that graduated from M. A. C. and his familiar face will be much missed at our reunions. He was a prominent farmer and influential man in his county.

Frank S. Burton, of the class of '68, died at Ann Arbor, Mich., on the 5th of January, 1897. At the time of his death he was a lawyer.

Frank P. Davis, also of '68, died at Guayaquil, Ecuador, S. A., on the 3d of May, 1900. Mr. Davis was a highly skilled engineer and was civil engineer of the Guayaquil & Quito R. R.

George D. Moore, '71, a farmer, prominent in Grange work. Died at Medina, Mich., on Feb. 4, 1900.

Arthur A. Crozier, class of '79, died at his home in Ann Arbor, Jan. 28, 1899. For four years previous to his death Mr. Crozier had held the position of Assistant Agriculturist of the Experiment Station here at the College, and had made hosts of friends both here and abroad. He was an eminent botanist and devoted to his work, and has left behind him many testimonials of his hard and earnest endeavor in the shape of valuable bulletins.

Charles W. Crossman, of the class of '82, died at Memphis, Tenn., on September 2, 1897. Mr. Crossman was a dealer in real estate.

William S. Baird, of '85, died at his home in Los Angeles, Cal., on Jan. 10, 1898. The death was caused by consumption, from which he had been a sufferer for some years. Mr. Baird was engaged in the practice of law.

Chas. S. Whitmore, '87. Mr. Whitmore had been a farmer and at the time of his death was employed as salesman for the McCormick Machine Co. Died at Utica, N. Y., August 19, 1899, after a very short illness.

Mrs. H. T. French, '87 (Carrie M. French). Died April 28, 1899, Moscow, Idaho.

Miss Grace L. Fuller, '91, died at her home near the Agricultural College, Jan. 2, 1900. Miss Fuller engaged in teaching at Lansing and in the East from the time of her graduation till her marriage in September, 1899, to Leander Burnett. She was a charter member of the first woman's society at the College, and we old girls remember her with a great deal of affection. Steady, earnest and sure, Grace was always to be relied on.

Gilbert H. Hicks, '92, died at Washington, D. C., Dec. 5, 1898. Mr. Hicks was, at the time of his death, first assistant chief of the Division of Botany, which position he had won by hard and patient work. Previous to going to Washington he had been instructor in botany at the College and his memory is very precious here.

Robert B. Pickett, '93. Died Sept. 3, 1897, at Springport, Mich.

Walter G. Amos, of '97, manager of the Chicago office for Murphy Iron Works, of Detroit, died at his home in Morgan Park, Ill., March 22, 1900. Mr. Amos' death is particularly sad, as he was a young man in the best of health and doing remarkably well in business. Only three weeks before his death he attended the banquet of the M. A. C. Association in Chicago, and on the very day of his death Mr. Woodworth had a letter from him in reference to some business connected with this association. When Llewellyn Reynolds, of '95, came out to our home in Chicago to bring us the news, we could not make it seem true. Mr. Amos was returning to Morgan Park in the evening and as he went to alight from the train his foot slipped in some way and he fell, breaking his leg. He was taken to his home where the fracture was set, and after the operation he went quietly off to sleep to wake no more. Only a very few of his College friends heard of it in time to attend the services.

Charles E. Townsend, of the class of '98, died at Onondaga, Mich., April 13, 1900. Mr. Townsend spent the first year after graduation in teaching, but ill health forced him to lay down his work, and after a year's suffering he passed away.

There has been one death in the College circle, not that of an alumnus, which yet cannot be omitted from this list; that of Mrs. Henry G. Reynolds, who died at her home in Pasadena, Cal., January, 1899. During her nine years' residence on the campus Mrs. Reynolds won the hearts of all who knew her by her cordial warm-heartedness and hospitality. We who were fortunate enough to have been students at that time carry many happy memories of pleasant evenings spent at her home. To all of us who knew her the news of her death came as a personal sorrow. I have in my possession a letter written by Mrs. Reynolds at the time of Will Baird's death, under the circumstances, which contains one paragraph that it seems a duty to read. "I was much with Will Baird before he died. I have always wanted his College friends to know what a cheery, brave life he led, and how calm and beautiful was his death. I have never seen one more so. His thoughtfulness for others while in severe pain and weakness was wonderful."

With bowed heads and reverent hearts we accept our Father's will. May his call find us all as ready.

COMMENCEMENT EXERCISES.

COMMENCEMENT DAY—FORTY-THIRD SESSION MICHIGAN AGRICULTURAL COLLEGE, JUNE 15, 1900.

Louis L. Appleyard, Charles W. Bale, William Ball, Antranig G. Bodourian, Harry L. Chamberlain, Alice M. Cimmer, George B. Fuller, Hugh B. Gunnison, Charles H. Hilton, Abraham Knechtel, Charles W. Leipprant, Bertha E. Malone, Wilfred B. Nevins, Clare H. Parker, Ellis W. Ranney, Harriette I. Robson, Charles H. Spring, Paul Thayer, Irma G. Thompson, John R. Thompson, Harvey A. Williams.

The degree of master of science, in course, was conferred upon A. B. Cordley, '88, and Wendell Paddock, '93. Hon. Jason E. Hammond, '86, State Superintendent of Public Instruction, received the honorary degree of master of science, and the degree of master of agriculture was given to William Caldwell, '76.

COMMENCEMENT EXERCISES.

By ten o'clock the armory was crowded by students and the friends of the College. After a selection by the M. A. C. band, the Board of Agriculture, faculty and graduating class marched to their seats upon the platform. The invocation was given by Rev. Mr. Odlum, and was followed by a piano duet by Misses Hudson and Goodrich. Miss Robson represented the Woman's Department, and in her address, "Woman and Her Relations to the Outside World," discussed woman as she is today, as she has been and may be, rationally and sensibly from her standpoint as woman and graduate.

Mr. Thayer took the subject "Conservation of Food." He explained how scientific agriculture has resulted in greater production per acre and better crops, how the poorer soils are and may be made fruitful, how exhaustion of the soil may be put off almost indefinitely. The vocal solo by Prof. Joslyn was much appreciated. Mr. Thompson, for the mechanical graduates, in speaking of "Rapid Transit from an Engineering Standpoint," compared the methods of the present with those of the past in engineering work, and brought out by many examples the wonderful achievements of the profession. He explained the part of the civil, mechanical and electrical engineers in the great things which have been accomplished.

Booker T. Washington, of Tuskegee Institute, Alabama, was the orator of the occasion, and gave the following address:

SOLVING THE NEGRO PROBLEM IN THE BLACK BELT OF THE SOUTH.

For a number of years I have tried to advocate the advantages of industrial training for the negro, because it starts the race off on a real, sure foundation, and not on a false, deceptive one.

Last year, when in England, I observed in Birmingham, London and elsewhere, in the large polytechnic schools, that thousand of men and women were being trained in the trades that cover work in the earth, in metal, wood, tin, leather, cloth, food preparation and what not.

When I asked, why do you give this man or this woman training in this or that industry? the answer came that when these students come to us we ask in each case, what are the prevailing occupations of the people in the community where the students live? In a word, it is found out what the student can find to do in his immediate community, not what he ought to find to do, not what the instructors might desire him to do, but what the economic and other conditions prevailing in his neighborhood will actually permit him to do.

With this knowledge obtained, the student was trained, for example in leather, because at his home that was the prevailing industry; that was the occupation at which he could find immediate and profitable employment. The same logical and common sense principle should be applied to the negro race. For example, the great bulk of our people live directly or indirectly by work in the soil. This gives us a tremendous advantage in the way of a foundation.

* * *

From the beginning of time agriculture has constituted the main foundation upon which all races have grown useful and strong.

In the present condition of the negro race it is a grave error to take a negro boy from a farming community and educate him in about everything in heaven and earth, educate him into sympathy with everything that has no bearing upon the life of the community to which he should return, and out of sympathy with most that concerns agricultural life. The result of this process is that in too many cases the boy thus trained fails to return to his father's farm, but takes up his abode in the city and falls in too many cases into the temptation of trying to live by his wits, without honest productive employment. And, my friends, if there is one thing at the present time that should give us more serious concern than another, it is the large idle class of the negro race that linger about the sidewalks, bar rooms and dens of sin and misery of our large cities.

Every influential man and woman should make it a part of his duty to reach the individuals of this class and either see that they find employment in the cities or are scattered to the four winds of the earth in agricultural communities, where they can make an honorable living and where their services are needed.

If it be suggested that the white boy is not always thus dealt with, my answer is: My friends, the white man is three thousand years ahead of the negro, and this fact we may as well face now as well as after,

and that at one stage of this development, either in Europe or America, he has gone through every stage of development that I now advocate for the negro race. No race can be lifted till its mind is awakened and strengthened. By the side of industrial training should always go mental and moral training. But the mere pushing of abstract knowledge into the head means little. We want more than the mere performance of mental gymnastics. Our knowledge must be harnessed to the things of real life.

* * *

Again, it is asked, would you limit or circumscribe the mental development of the negro boy? Emphatically I answer with a hundred "noes." I would encourage the negro to secure all the mental strength and mental culture, whether gleaned from science, mathematics, history, language or literature that his pocketbook and circumstances will enable him to pay for; but I repeat with all the emphasis of my soul that the greatest proportion of the mental strength of the masses will be brought to bear upon the every day practical affairs of life, upon something that is needed to be done and something that they are permitted to do in the community where they reside.

When it comes to the professional class which the negro needs and must have, I would say, give that training which will best fit them to perform in the most successful manner the service which the race demands. But would you confine the negro to industrial life, to agriculture, for example? No, but I would teach the race that here the foundation must be laid, and that the very best service which anyone can render to what is called the higher education is to teach the present generation to provide a material or industrial foundation.

On this industrial foundation will grow habits of thrift, the love of work, economy, ownership in property, a bank account. Out of it in future generations will grow classical education, professional education, positions of public responsibility. Out of it will grow moral and religious strength. Out of it will grow that wealth which brings leisure, and with it the enjoyment of literature and the fine arts. In the words of the late Frederick Douglass, which I quote. "Every blow of the sledge hammer wielded by a sable arm, is a powerful blow in support of our cause. Every colored mechanic is, by virtue of circumstances, an elevator of his race. Every house built by black men is a strong tower against the allied hosts of prejudice. It is impossible for us to attach too much importance to this aspect of the subject. Without industrial development there can be no wealth; without wealth there can be no leisure; without leisure, no opportunity for thoughtful reflection and the cultivation of the higher arts."

I would set no limitations on the attainments of the negro in arts, letters or statesmanship; but, my friends, the surest and speediest way to reach these ends is by laying the foundation in the little things of life that are immediately at our door. The man who has never learned how to make money to pay his own debts is not the one to be intrusted with the duty of making laws to pay the national debt.

* * *

I have read recently an account of a young colored man in the District of Columbia, who graduated from college and from a school of tech-

nology, and then what? He did not go about seeking for a position which other brains and other hands had created, but used his knowledge of the sciences and mathematics in creating a bootblack establishment, where he manufactures his own blacking and polish. Starting with one chair, he now has a dozen; starting with one place of business, he now has several. What matters it to this man whether Republicans, Democrats or Populists are in power in Washington? He knows that he has a business that gives him independence, and with its expansion and growth will come wealth and leisure and the highest educational opportunities for his children. Oh, for a thousand men with the force of character and common sense to begin on such a foundation.

It is not alone the mere matter of the negro learning this or that trade for which I plead, but through the trade, the industry; out from the trade or industry I want to see evolved the full-fledged, unhampered, unfettered man. I plead for industrial development, not because I want to cramp the negro, but because I want to free him. I want to see him enter the great and all-powerful business and commercial world.

* * *

If for a brief moment you will excuse me for the seeming egotism, I will tell you what a set of devoted colored men and women have done at Tuskegee, Alabama, during the past nineteen years.

Beginning in 1881, with absolutely no property, the Tuskegee Institute now owns 2,500 acres of land. Of this amount about 700 acres are this year under cultivation. There are upon the school grounds forty-eight buildings, and of these all except four have been wholly erected by the labor of the students. Students and their instructors have done the work from the drawing of the plans and making of the bricks to the putting in of the electric fixtures. There are fifty wagons and buggies and 600 head of live stock. The total value of the real and personal property is $300,000. If we add to this our endowment fund of $165,000, the total value of the property is $465,000, and if we add to this the value of the 25,000 acres of public land recently granted to this institution by congress, the total property of this institution is $590,000. The students earn by work at their trades and other industries about $90,000. The total monthly expenditure is nearly $7,500. The total daily expenditure is not far from $250.

Beginning with thirty students, the number has grown until at the present time there are connected with the institution a thousand and more students from twenty-four states, Africa, Jamaica, Cuba, Porto Rico and other foreign countries. In all of our departments, industrial, academic and religious, there are eighty-eight officers and teachers, making a total population on our grounds of about 1,200 people.

During the nineteen years the institution has been in existence hundreds of students have finished the academic and industrial courses, and if we add to the number about 2,000 students who were not able to remain and get a diploma or certificate, who nevertheless got the spirit of the institution and a knowledge of industry to such an extent that they are doing good work as teachers, as farmers, as tradesmen, as leaders of thought, industry, thrift, morality and religion, the number can safely be placed at nearly 2,500.

* * *

Not a single one of our graduates has ever been convicted by any court of crime. Not a single one of our graduates has ever been charged with the crime of attempting an insult upon a woman.

At least half of these students are working in part or wholly at their trades or industries, which they learned at Tuskegee. Whether they are working at the immediate trades which they learned or not, all have the spirit of industry and thrift that makes them valuable citizens. The Tuskegee Institute does not confine its work to the industrial training. Along with industrial training goes thorough mental and religious training. We keep in constant operation, at which the students receive training, twenty-eight industries. All of these are industries at which our students can find immediate employment, as soon as they leave the institution; in fact we can begin to supply the demand for our graduates, and a large portion of these demands come from Southern white men and women. We can now erect a building of any kind without going off the grounds to employ a single outside workman.

WOMAN AND THE OUTSIDE WORLD.

HARRIETTE I. ROBSON, REPRESENTING THE WOMEN'S COURSE.

Ours is an age of questioning. Because of questioning, ours is also an age of reform. Society's ideals have risen, are still rising, and the world is moving into a new and hopeful century.

We expect great things for the future of our land and our people. We believe in the potency of our end-of-the-century enthusiasms for humanity—the earnest, hopeful seeking, not merely to know the truth, but to use it for humanity's sake. We believe, also, in the reciprocal willingness of humanity to be improved; that is, we believe in the universal desire of the individual to make the most of himself and his opportunities. Lastly, we believe in ourselves. We feel that those proverbial traits of American character which have given a materialistic trend to our national activities, can also give us wisdom in solving some of our present-day problems, as well as those which the era of "good will toward men" will bring with it.

Everything is a problem today. Among others is the much-discussed, long-suffering "Woman Question." One would suppose it had grown thread-bare long ago; and so it has—only the warp remains because the whole was woven on truth.

Granted that a woman is a free spirit, who is an end in and for herself; granted that hers is a soul as deep, as aspiring, as divinely different from every other human being's as is a man's; granted her capacity for reasoning, as some one has said, "beyond the limits of the proverbial woman's reason;" granted that as a free, intelligent, social being, she desires to do, and must do, her share of the world's work—who can deny her the broadest, freest possible expression of her own best self? The matter of her "right" to participate in the world of affairs is today

very generally recognized; it has become rather a question of what it is that, in the solving of her own life problems, she can best give to her age. What is to be her own peculiar, individual work?

We know that women have been one of the greatest regenerating forces in our civilization, and that through the ennobling of their position in society has come the ennobling of the race, but we do not know, as yet, just what man's part and woman's is in the ideal state of today. We are living too near our own times to say. But in the complex ordering and the many-sided issues of our modern life, the necessity of building well-rounded, completed men and women into our national and social life must be apparent to all.

The wealth of possibility in our American women is past computation. Deep in their souls are planted the formative ideals of our race—virtue, duty, courage, sincerity, piety. Year by year, century through century, the little plant has been pruned and nurtured, until today we are ready to reap a richer harvest than ever before. But before the harvest can be full, certain elements must be eliminated. Consider the question broadly and fairly; just what is the existing condition of the average American woman today? Is she free?

A more rational education than of old, greater liberty of thought and action, have done much for women in the last fifty years, but the traditions of centuries have been too strong for them; they have not yet been able to free themselves from the primitive conceptions of the prescribed activities and duties of their sex. Their slavery takes various phases and forms, but the fetters may, broadly speaking, be traced to a common source—ignorance of self.

The be-good-and-let-who-will-be-clever ideal of womanhood has still a tremendous hold on the feminine mind. It does not see that mere negative, sentimentally ornamental goodness can never be effective. Goodness, to be a power in the world, must go hand in hand with cleverness, must exercise itself and grow. In contrast to the inane woman, is the other extreme—the dogmatic woman. To her, what I think will have greater force than what is truth. She is apt to dissipate her energies on mere abstractions, and, seeking to broaden women's lives, but failing to understand either herself or the wide differences in the needs of the individual life, she attempts generalizations and cries for "woman's rights"—not the rights of women—somewhat as the French revolutionists clamored for the "rights of man."

Women need more positive ideals of goodness and greater individuality. They need the broadening and deepening influences of the constant interflow of their lives with the life of their time. To meet these needs, women must themselves consciously broaden their interests and look at themselves in their relation to the whole of society. They are too apt to see only what is close to them, and hence to see without sense of proportion or relation to natural law. What is it that makes the daily care of the household a drudgery? The too busy housewife must cook one hour what is eaten the next; must dust today what will be dusty again tomorrow; must mend here, patch there; always working, yet never gaining—what is it that makes it all so hopeless? Is it not the failure to see the meaning, the value of these necessities to our health and happiness and to understand the proportion of thought and time which

they can reasonably claim in our life? Women do not need to think more of these things. They must think less of them, but to more purpose. They must find time somewhere for the duties which they owe to themselves.

The four walls of the home have limited women's activities too long. A too close attention to our daily wants has confined their souls to the world of little things. We must not consider the home a little world by itself, shut off from all the rest of the world and its interests. On the contrary, the home is the very heart of our social body; from it are forced the life-giving elements into all the organs of human activity. The character of our home life means more, will accomplish more for society than any legislation or reform ever can. We feel that the best that culture and science can give it, is none too good. How imperative, then, that the woman in that home should be a wise, cultivated, high-minded woman, and that her outlook on the world into which she is building should be broad and free, and that her soul be unhampered to express itself freely!

What is to help her to a freer, more comprehensive womanhood? Many things may help her, but whatever a woman is, that she will always be. Education and environment may influence her, but she can never quite separate herself from herself. No one can. But a higher education is, perhaps, the greatest help she can have in realizing her true self. It need not, perhaps ought not, to be identical with a man's in every particular, but it must certainly be as comprehensive. It must teach her first of all, to be.

To do this, it must meet three requirements. First, it must be broad. It must call into play all the powers of her being; it must teach her to feel as well as to think; and it must give her such an outlook that she may see the universe in its true proportions, and her own relation to it.

Second. It must be personal. It must permit such freedom in election of subjects that, in addition to what we may call the universal or broadening element, the cravings of her own individual nature may be satisfied and her inherent gifts and capabilities drawn out and developed. The girl who finds her ideals of the good, the true, the beautiful, in music or art, may not care to go deeply into the classics, nor will the girl whose higher nature is fed by the vastness of science or mathematics be likely to make literature her specialty. Yet the education of each may be made equally as broad.

Third. It must contain enough of what we are pleased to call "the practical" to enable her to lay hold of the common duties and affairs of life intelligently and easily.

After her four short years of college training, a girl will have learned many things besides what she has found in lecture-room or laboratory. She will have gained the independence and steadfastness of purpose which results from serious work done shoulder to shoulder with other workers; she will have learned not to be afraid of her enthusiasms and her honest, because rational, convictions; from the cosmopolitan character of college society she will also have gained a peculiarly true understanding of, and sympathy with, human nature. She will understand, even though perhaps only in a vague way, the common ties and aspirations which, after all, make humanity one in essence.

Some rather ultra-conservative persons have feared that with the acquisition of these sterling, though perhaps more stern qualities of character, women would become mannish, would lose those charms and graces which have always been theirs. But nearly half a century of experience has proven that no amount of education can render the woman who is made of the right material in the first place, unwomanly or unlovely. True, she may, indeed, have lost that superficial, fluffy, insipidity and those bric-a-bracish propensities which we have in some way come to consider a part of "the eternal feminine," but she will have gained in their place vivifying, life-transforming power of noble aim and purpose. She will have found instead that whatever fate may put therein, her own life is worth living out bravely to the end; that while she may not be free to go and come at will, there is yet time in her life for all good things—time for work and time for play; time for the every-day divine sweetness of life, time for the "mountain visions." Above all else, she will have begun to become a little acquainted with herself, to see what it is in her nature that distinguishes her from every other being in the world, and to decide in what sphere of activity this distinctive self will find its best expression and use.

So, in considering what it is that a woman is to give to her age, we may say that, first of all, she must become a part of her age. She must hold her soul open to both give and receive that inspiration and sympathy which is to help harmonize and unify mankind. Then, while a woman gives, consciously or not, of all that she is, she will be able to give it most effectively through what she does—through her work.

Let this work be whatever her own capabilities and highest happiness may determine, but let her do it with the conscious hand and will of the master workman. It is a duty she owes both to herself and to society. In doing this work of hers, whatever it may be, she need not become in any way eccentric, unlovely or unmindful of the common ties of human affection and duty. On the contrary, all that she can put into her work of the magnetism of her own vivid womanhood will but add to her helpfulness and her power over the minds and hearts of those whom her life will touch. We do not want hard, cold, merely intellectual brilliant women, but we do want women who understand themselves and whose lives are warmed and brightened by purpose, and who realize that, merely because they are women, they are not exempt from the duty of putting their individual talents into active use for the world.

If they feel that it comes to them in the right way, the great majority of women will find, as they always have found, their highest and certainly most ideal happiness in the activities of the home. Here, indeed, is a field of work and influence so vast in scope, so eternal in meaning, that the best a woman can put into it is all too meager. And the women of the future will be prepared to give their best to it. Understanding the needs of their own inherent natures, they will enter the home of their own free will, because here was the satisfaction for which their souls were seeking, and not because it is the fashion to marry, or because most women do.

But if this factor never comes into a woman's life, or if she feels

that her particular being will grow and develop best in the freer atmosphere of the busy world, her work as certainly lies there.

There is still no reason why the two, the professional woman and the mother of the household, may not react favorably upon each other; why they cannot both work in their own way for the same end—a freer, nobler, more all-embracing manhood and womanhood.

THE CONSERVATION OF FOOD.

PAUL THAYER, REPRESENTING THE AGRICULTURAL COURSE.

The tendency of all nature is to move in cycles. The better we understand the processes of nature, the more clearly do we see that they are all in accord with this inexorable law. The revolution of the planets and the succession of day and night are but common illustrations of this law. We see it in the caterpillar emerging from its crysalis a butterfly, or the buried seed springing into the growing plant, yet we often forget that the same law as certainly governs the invisible atoms in their combinations and changes. We learn in physics of the conservation of energy, how energy can neither be produced nor be destroyed by human might. We can divert it or dissipate it, but never destroy it. There is a striking parallel in the case of our food. When once used it is not destroyed, but returns, in time, to the earth and air to again be changed into forms such as can be utilized by man. That this similarity between conservation of energy and conservation of food is not appreciated by the mass of the people, is seen in the expressions we use. We speak of land as being "worn out" or "exhausted," as though it contained a definite and constantly decreasing amount of material capable of supporting life, and that every crop removed brought the soil just so much nearer exhaustion. Such a conception leads us to sometimes wonder what is to be the future of the world. As the tillable soil of the world gradually becomes exhausted, will not starvation be the fate of the race? Is, after all, the theory of Malthus that the population would ultimately exceed the food supply, to be finally realized?

We will leave the question of increase of population, with its many intricate phases, and turn our attention to the various factors that enter into the food production. No one will doubt for a moment but what the world today provides amply for its inhabitants. Never was the world better fed; never did it require so little labor for the workman to provide food for himself and his family, and never did we have so much time in which to provide other comforts and luxuries.

The famine in India today is not the result of lack of food, but insufficient and faulty transportation and distribution. In considering the production of food we commonly think of the tillers of the soil as alone affecting production, while in reality it is also affected by every improvement and agency which facilitates distribution.

In considering the future of this problem we cannot but admit that

the population of the world is increasing and will probably continue to increase. As an offset to this, there are many fertile places in the world which are at present worthless and neglected because they are practically inaccessible. There are thousands, aye millions, of acres of land capable of producing food, which only await the coming of the railroad and the farmer to yield their fertility for the use of man. Africa is still the "Dark Continent," and awaits development. South America is but little better than half developed, and our own country has still fertile lands which the plow has never entered.

Not only is transportation opening new lands, but improved methods of agriculture are rendering lands, hitherto unprofitable, of sufficient value to warrant cultivation. Pessimists point to the occupation of poorer lands as a proof that our food supply is becoming limited, but it rather shows that improved methods have greatly enlarged the territory capable of profitably producing food.

When we call to mind this great possible increase of tillable land, when we think of the sparsely settled portions of the world and contrast their population with the population they might contain, it would seem that the day when starvation would threaten is too far distant to attract much attention. May we not fairly assume that the increase of land under cultivation will offset the increase of population for many centuries before all the land capable of producing food shall have been used?

But what is to be the future of the land already under cultivation? Will it deteriorate in productive ability as successive crops are removed? There is an old familiar saying that "the granary is the ante-room of the desert," meaning that as successive crops are raised, the land becomes depleted. As an example of this we are directed to Egypt, which but for the annual enriching as it is overflowed by the Nile, would soon become a desert. Unless we are able to give up this idea of the earth as a storeroom, we can see no future but final starvation.

The earth is not a granary or storehouse. The food produced is not destroyed when consumed. It is conserved, changed, it returns to the earth and air in the state in which it was before the plant, under the influence of the sunlight, assimilated it and built it into grain or fruit. Holmes expresses this thought so happily when he speaks of man as simply "peeling off the sunshine" in the food that he eats. It is the sunshine that we use, since the elements of the food return to their original state in the earth or air.

We must abandon the idea of the earth as a storehouse. It gives the mother earth too lowly a station and to the farmer too mechanical a task. It is a laboratory, a workshop, where by proper manipulation and combination the crop is produced. Like any workshop or factory, as the efficiency of its management increases the product will be increased. The yield of wheat per acre in the United States is yearly increasing. China is as fertile today as it was 3,000 years ago. A proper understanding of the laws of agricultural chemistry and of the physical nature of the soil will give us a far greater yield of food.

For example, let us take the law of minimum. A soil may have all the necessary physical characteristics; it may have all the requisite chemical elements save one, yet in obedience to this law the productive-

ness of the soil will be governed by the amount of this least element. If the farmer can increase the amount of this least element, he will in the same proportion increase his crop.

Improved methods of agriculture will mean the prevention of loss. The constant loss of nitrates and other valuable salts by drainage is enormous. If this loss can be partially checked it will go far toward the preservation of the fertility of the soil. In an ideal condition everything removed from the soil would be finally returned to it, and thus the fetility would be constant. Of course, some loss is not to be avoided, but to offset this we have the vast resources upon which we have already begun to draw, the phosphate beds of South Carolina and the nitre beds of Chile.

The importance of bacteriology in regard to agriculture can hardly be estimated, since comparatively little is known about the subject. Enough has already been discovered to warrant the assertion that this new science will have a marked influence. Nitrogen enters into combinations fitted for plant food so slowly and these compounds decompose so readily that combined nitrogen is one of the most precious of plant foods. It has been said that the man who could discover a method of causing the nitrogen of the air to readily enter into combination would double the food supply of the world. Such a method has not been found, if we except Nicola Tesla's wonderful experiment, yet a knowledge of the nitrifying and denitrifying bacteria of the soil will go far toward placing the supply of available nitrogen under control of the farmer.

Not only is the food question to be affected by methods of cultivation, but it is to be affected by the kind of food consumed. There seems to be a growing tendency toward an increase in the consumption of carbohydrates, sugar and fruits (foods which draw but little upon the elements of the soil), and a decrease in nitrogenous foods. The elements of these carbohydrates and sugars are the elements of the air and water and are inexhaustible.

Let us therefore accept Holmes' idea that as the elements of our food pass through their cycle from the earth to the earth again, we simply "peel off the sunshine." So as long as the sun continues to shine upon us, sending its energy through so many miles of space to this planet, so long we need have no fear of starvation, or that the world will be unable to feed its inhabitants.

RAPID TRANSIT FROM AN ENGINEERING STANDPOINT.

J. R. THOMPSON, REPRESENTING THE MECHANICAL COURSE.

In these closing days of the nineteenth century we pause and look back with wonderment and awe upon the marvelous changes which have taken place in it. Whichever way we turn we find improvement and advancement, but more especially do we find this to be true in the engineering world.

When we look back through the ages, even to the opening of the present century, and see the slow-moving ox-cart wending its way westward, the seas dotted with the canvas of sails, and when we hear that what is now a few hours' journey could be accomplished in no less than a week's time, we are amazed at the wonderful improvement a century has brought about.

One hundred years ago people were but little further advanced along certain lines than they were at the dawn of civilization. Our forefathers traveled as did their forefathers ages before them. Today all is changed, and we are fortunate to be living in this most progressive epoch.

One of the most marked lines of advancement made in engineering, as well as one of the most recent, is the improvement we find in our means for rapid transit. It is within the memory of many a man still living that the horse-car was first thought of, and within the memory of most of us that the idea of driving the car by other than animal power was made practical. It is but twelve years ago that the idea of passing a 500-volt current through an exposed overhead wire was thought by many to be the height of folly. Today nearly every city of importance has changed its street railroad system from the slow-moving horse-car to the well lighted and equipped car propelled by electricity.

It is only of late years that the demand for rapid transit has become so marked. This fact is due to the enormous increase of population in our cities and the necessity of more efficient means to satisfy the needs of the ever-hurrying American.

It was by this necessity that men of the engineering profession were called upon to show their ingenuity. The efforts of these men have met with success beyond the hopes of all, but their success has not been won without a struggle.

In the year 1888 a few energetic men in the city of Richmond, Va., came forward with the idea of transmitting power to a car by electricity through an overhead wire. After striving against antagonized citizens, and passing through the trials and difficulties common to inventors and adventurers, a system was finally installed.

This somewhat crude system established but twelve years ago stands today as an elder parent to the excellent system of rapid transit by power transmitted electrically which we now find existing throughout our country.

When we realize that the dynamo has been in practical use only about twenty-five years, and recall how poorly adapted the steam engine

was to run it at its introduction, we are amazed to find such wonderful improvement in so short a period.

Probably since James Watt made his improvements upon the steam engine, there has been nothing that has given so much impetus to the engineering world as the universal adoption of electrically driven cars as a means for rapid transit. It has opened new fields for the three engineering professions, civil, mechanical and electrical.

The civil engineer must better the line construction, making it more substantial, and capable of standing heavier strains. Overhead roads and tunnels have become a necessity in the more thickly populated portions of our large cities. Bridges before unthought of, or considered impossible of construction, have been designed. Only a few years ago the Brooklyn bridge was looked upon as a marvelous piece of engineering, but today people regard as almost a matter of course the new North River bridge, which when completed will outclass the former in every particular. The tunnels of our large cities may be looked upon as feats of modern civil engineering to which the demand for rapid transit has given rise.

The duties of the mechanical engineer lie at the base of all sources of power and the advancement made necessary in the mechanical field by the need of more rapid means for transit has been of much importance. There are in general but two main sources of power; first, the conversion of the energy stored up in coal, or its products, through the heat engine; and second, water power. There are so far as we know today no material sources of electricity, so we must depend on one of these sources of power to develop it.

When the dynamo was first put to practical use it had to be run with high velocity. The only engine then in use was a slow-speed one, with the ball governor in no better condition than it was left by James Watt. The water turbines of that time were no better fitted to run at the enormous rate required, consequently elaborate counter-shafting became necessary and much power was lost through transmission.

The mechanical engineer had serious problems to face. He must have an engine that would run, at what seemed in that day, an almost impossible speed. It was necessary to devise some better means for governing, and the new engine had to be capable of standing heavier strains than was ever demanded of the old.

To increase speed necessitated higher pressures, and higher pressures necessitated more efficient and stronger boilers.

The mechanical engineer has worked long and diligently and his labors have been fittingly rewarded. The question of speed has been solved and today we find in our best power plants either the dynamos belted directly to the engines or mechanically connected with them. Regulation has been perfected to such a degree that a monstrous engine will respond to the least variation in load. Thermo-dynamic losses have been gradually reduced, and today we see our steam engine so highly perfected that it is not probable that it will be bettered till some genius comes forward and shows to the world the method of direct conversion of the energy of chemical forces into mechanical energy, and when that day shall come, our present engine, of which we are so

proud, will undoubtedly appear as wasteful and as inefficient as the engine of one hundred years ago does to us.

The advancement made by the electrical engineer in the last thirty years has kept pace with that made by the mechanical and civil. With almost nothing to guide him, he has in a remarkably short time mastered the fundamental principles of the science of electricity and has perfected his dynamos, transformers and other machines, so that it is now possible to transmit currents of very high voltage long distances with very little loss.

By the use of these machines for transmission, the enormous power, which has for ages been going to waste at our waterfalls, can be distributed to the surrounding country. Niagara alone is estimated at 20,000,000 horse power, which is 200 times as great as the largest plant where energy from the coal is converted into useful work.

Since the development of rapid transit has attained such perfection there has been much discussion as to whether electricity will replace steam on our trunk lines.

Speaking from the standpoint of economy, I think we can justly say it will not. When a man wishes to reach his place of business from his residence, he will patronize the line which can offer him the best accommodations. The electric line will stop for him at his door and if he misses a car it matters little as generally another follows closely. With the steam lines he must board the train and leave it at a station, and as a rule the cars do not run as frequently as do those on the electric line. On the other hand, if the traveler wishes to cross the country, a few hours' delay and a short walk are of little consequence. When frequent trains, then, are to be run, for a comparatively short distance, it has been found economical to have a central station, at which power is furnished for all the cars on the line, but on the other hand, when the trains are composed of several cars and are run with a long interval between them, it is cheaper to have a distinct source of power for each train. The electric and the steam roads serve entirely different purposes. Each has its field, just as have the telegraph and the telephone, and it is doubtful if we will ever see the latter entirely superseded by the former.

So much has been done in the last thirty years to perfect our means of transit that some may be inclined to think that men of the engineering professions may turn their minds to other thoughts, and, like the great Alexander of old, seek other worlds to conquer. This, however, is not the case. Prospects are favorable that the next thirty years will produce as marvellous changes in locomotion as have the past.

Man has long envied the bird in its flight and wondered why

"The Robin and Phebe
Are smarter than we be."

As man is becoming more and more master of the slaves he now has but partly under control, he is getting more and more work out of them. Today a little over one-tenth of the energy stored up in the coal is available at the shaft of an engine. The bulk of machinery is gradually being reduced, and with the lightening of the load which man must

carry with him if he leaves the earth, there seems to be nothing to prevent his following the birds in their flight.

The world is still waiting for the genius who is first to give her the commercial means of aerial navigation. Some may be inclined to smile at the suggestion, but if they had lived a hundred years ago they would, also, have doubtless smiled at the prophetic words of Darwin when he said:

> "Soon shall thy arm, unconquered steam, afar
> Drag the slow barge or drive the rapid car,
> Or on wide, waving wings, expanded, bear
> The flying chariot through fields of air."

STATE ASSOCIATION OF FARMERS' CLUBS.

OFFICERS FOR 1900.

President—D. W. EDGAR, Green Oak.
Vice President—MISS JULIA BALL, Hamburg.
Secretary—H. M. YOUNG, Mason.
Treasurer—MISS HELEN CARPENTER, Hanover.

DIRECTORS.

Term expires 1900.

H. Gaunt	Highland.
A. P. Green	Eaton Rapids.

Term expires 1901.

C. S. Johnson	Milford.
W. H. Crafts	Leoni.

Term expires 1902.

C. E. Hadsell	Troy.
J. Sessions	Maple Rapids.

The Michigan State Association of Farmers' Clubs is now in the midst of the seventh year of its growth and work. From its inception it has steadily grown in strength and popularity, and this year bids fair to surpass all previous years. The last annual meeting was held in the Senate Chamber in Lansing, on December 11 and 12, 1899. This was, by far, the most satisfactory annual meeting yet held. Upwards of 300 representatives from various clubs in the State were in attendance. The secretary's report showed 32 new clubs organized during the year. At the opening session, Mr. Howe, Chief of the Division of Agricultural Statistics, gave the association a warm welcome to the capitol. The report of the secretary and treasurer followed, after which several impromptu speeches were enjoyed, one of which was by Hon. H. W. Collingwood, editor of the "Rural New Yorker."

After the announcement of the following committees by President Watkins, the first session adjourned:

Committee on National Affairs—W. E. Carpenter, Oakland county; J. H. Skinner, M. A. C.; C. E. Hadsell, Oakland county; R. R. Smith, Livingston county.

Committee on State Affairs—J. T. Daniells, Clinton county; J. W. Edgar, Livingston county; C. S. Johnson, Tuscola county.

Committee on General Resolutions—E. F. Wood, Oakland county; David Gage, Oakland county; H. R. Palmer, Jackson county.

Committee on Amendments to the Constitution and By-Laws—H. Gaunt, Livingston county; E. J. Cook, Shiawassee county; Miss Julia Ball, Livingston county.

A large crowd attended the evening session and the time was taken up with the president's annual address, and an address on "The Tax Commission" by Milo D. Campbell, president of the commission.

Music by the M. A. C. band was highly enjoyed by all.

The first part of the Wednesday morning session was devoted to the consideration of the committees' reports, after which ex-Gov. Luce gave an address on "The Farmer and Trusts." It was a masterly talk and closest attention was given to it.

The afternoon session was entirely given up to the final consideration of committee reports and the election of association officers for the ensuing year.

The election resulted as follows: President, J. W. Edgar of Green Oak; vice president, Miss Julia M. Ball of Hamburg; secretary, H. M. Young of Mason; treasurer, Miss Helen N. Carpenter of Horton; directors, C. E. Hadsell of Troy and Jay Sessions of Maple Rapids.

In the evening the Clubs and Grange met in joint session. President Watkins presided, and the following addresses were given: "The Status and Opportunities of the Farmer," by Hon. J. K. Campbell, of Ypsilanti; "A Review of the Work of the Legislature of 1899," by Governor Pingree; "The Education of Farmers' Girls," by Mrs. Mary S. Hines, of Stanton; "Agriculture," by M. J. Lawrence, of the "Michigan Farmer;" and "The Farmer of the Future," by J. T. Daniells, of Union Home.

This session closed the annual meeting.

The official organ of the Association is the "Farmers' Club Department" in the "Michigan Farmer." It is edited by Hon. I. R. Waterbury, of Highland.

H. M. YOUNG,
Secretary.

MICHIGAN STATE GRANGE.

REPORT OF WORK OF THE ORDER OF PATRONS OF HUSBANDRY IN MICHIGAN FOR YEAR ENDING JUNE 30, 1900.

OFFICERS FOR 1899-1900.

Master—G. B. HORTON, Fruit Ridge.
Overseer—E. B. WARD, Charlevoix.
Lecturer—MRS. FRANK SAUNDERS, Edgerton.
Steward—GEO. L. CARLISLE, Kaskaska.
Assistant Steward—WM. ROBERTSON, Hesperia.
Chaplain—MARY A. MAYO, Battle Creek.
Treasurer—E. A. STRONG, Vicksburg.
Secretary—JENNIE BUELL, Ann Arbor.
Gate Keeper—M. H. FOSTER, Cascade.
Ceres—ESTELLA KNIGHT, Swartz Creek.
Flora—RISPAH POST, Lansing.
Pomona—ESTELLA E. BUELL, Union City.
Lady Assistant Steward—MARY ROBERTSON, Hesperia.

EXECUTIVE COMMITTEE.

Term expires December, 1900.

Thos. Mars, Chairman	Berrien Center.
A. E. Palmer	Kalkaska.
W. E. Wright	Coldwater.
H. D. Platt	Ypsilanti.

Term expires December, 1901.

F. W. Redfern	Maple Rapids.
E. A. Holden	Lansing.
F. D. Saunders	Edgerton.

Members Ex-Officio.

G. B. Horton	Fruit Ridge.
Jennie Buell	Ann Arbor.

The year ending June 30, 1900, has been one of greater activity in every department of Michigan State Grange than any previous one since its organization, on April 15, 1873. All along its lines plans have been laid and leaders enlisted and trained to inaugurate more systematic zeal and attain a stronger union of the best thought and work of agriculturalists. The aim has been to instill a higher ideal of the meaning of the

terms "Organize," "Co-operate," and "Fraternal," not only into the minds of men and women who have been sought as new members of the order, but also into those communities where the subordinate Grange has had a more or less active existence for years. Up and down the State the purposes of the order have been proclaimed by officers and deputies. Again and again have they presented the cause of organization to gatherings of farmers, as summarized in "General Objects of the Grange," as follows:

"To develop a better and higher manhood and womanhood among ourselves. To enhance the comforts and attractions of our homes, and strengthen our attachments to our pursuits. To foster mutual understanding and co-operation. To maintain inviolate our laws, and to emulate each other in labor, to hasten the good time coming. To reduce our expenses, both individual and corporate. To buy less and produce more, in order to make our farms self-sustaining. To diversify our crops, and crop no more than we can cultivate. To condense the weight of our exports, selling less in the bushel and more on hoof and in fleece; less in lint, and more in warf and woof. To systematize our work, and calculate intelligently on probabilities. To discountenance the credit system, the mortgage system, the fashion system, and every other system tending to prodigality and bankruptcy.

"We propose meeting together, talking together, working together, buying together, selling together, and, in general, acting together for our mutual protection and advancement, as occasion may require. We shall avoid litigation as much as possible by arbitration in the Grange. We shall constantly strive to secure entire harmony, good will, vital Brotherhood among ourselves, and to make our order perpetual. We shall earnestly endeavor to suppress personal, local, sectional and national prejudices, all unhealthy rivalry, all selfish ambition. Faithful adherence to these principles will insure our mental, moral, social and material advancement."

In the work of promulgating these teachings a system has been devised and carried into effect by Worthy Master Horton, which calls for a large number of assistants, known as deputy lecturers or organizers, and who, scattered throughout the State, work in their immediate localities. The practical effectiveness of this system, as elaborated and persisted in now for several years, is shown by the organization of 116 new Granges in the past twelve months and in the doubling of membership, making a total of 413 active subordinate Granges and upwards of 20,000 members. The annual session of State Grange, held in Representative Hall, Lansing, December 12, 13, 14 and 15, 1899, was a large and enthusiastic meeting. Its pulse throbbed with fresh, vigorous life that betokened an awakened conscience in regard to the combining of farmers to better their conditions and uplift themselves. It showed a keener appreciation of the fact that "the chief incentive to labor past mere subsistence is social, educational, influential standing," and that the means to attain this lie in the extension of organizations. Master Horton gave voice to this general sentiment in these paragraphs from his annual address:

"At no time since the first formation of the order has there been greater activity among Patrons and in Granges throughout the country. Farmers are fast coming to see and admit that organization is not only

a privilege that may be employed for social benefit, but that it is also a necessity of the times to enable them to stand up against the aggressive movements of other organized interests which seek special advantages and selfish gain, even at the expense of others. Farmers are also coming to see that organization to be most useful and effectual, must be based upon business principles, which dictate a systematic plan of concentration with neighborhood, county, state and national bodies, with ample provisions for necessary amounts of money in all respective treasuries, and the whole bound together by the strong ties of sympathetic and real fraternity. The duties of membership in practical organization must be obligatory, and not optional to the extent of sacrificing adherence and solidity. In short, we must have thorough organization, and its work must be as broad as the interests of agriculture in the nation.

"Such an organization is the order Patrons of Husbandry. It came into existence about thirty years ago, had a real mission to perform, and now, rich in experience, it stands as the recognized state and national representative of the interests of agriculture. It is our organization that is solicited to appear and testify before International Commercial Inquiries, National Industrial Commissions, committees having in charge tariff revisions and nationl conferences on great questions which do or may seriously affect the general interests of agriculture.

"The time has come and our work has developed the fact that the order must be extended. We must increase our membership to be successful in many important lines of duty. We must have more Granges in every settled county. At the least, there should be one Grange in every township, and in most cases this number should be greatly increased, to give all farmers an opportunity to associate with a Grange by going an easy distance. One of the chief demands for more Granges and greatly increased membership is, that farmers being considered as the great conservative portion of our population to exercise a telling influence in favor of right and against wrong. We are all aware of the fact that Congress and the Legislatures are charged with the enactment of laws for just government, and to preserve such equilibrium between all legitimate interests as such just government demands. The farmer population of our country are in favor of supporting and maintaining these principles. To do this against the demands and corrupt methods of the extremely selfish and ofttimes unscrupulous persons and corporations for legislation for their own benefit often at the expense of the many, we must make our organization stronger. We must have more nearly all the farmers enrolled with us. Then we can stand by the side of our representatives and strengthen them to oppose any and all attacks and pleadings for unjust and vicious legislation."

In the work of the year the strengthening of the Pomona, or county Granges, has received much earnest attention and endeavor. The ends to be attained were in substance the following:

1st. Secure Pomona Granges in every county where subordinate Granges exist.

2d. Thoroughly renovate and bring up to date all existing Pomona Granges.

3d. All adopt by-laws, and live and work as a practical business body.

4th. Insist on the payment of at least the minimum annual dues by every member.

5th. Elect men and women to fill the offices who possess proven originative capacity, and a willingness to assist in details of execution.

6th. Hold at least six meetings each year.

7th. Try to arrive at parliamentary correctness, ritualistic perfection, and by all means use the special annual Pass Word as provided by the National Grange.

8th. Do all you can to encourage treasury receipts and use the money for the benefit of the order in the county, as wise yet earnest and active council may devise. The chief questions discussed in all Pomona Grange meetings should have special reference to the Grange and in such pertinent form as will add to the order's growth and increased usefulness. Questions relating to farm management and the ordinary affairs of life should be left with subordinate Granges to be discussed at their more frequent meetings, and which are more easily attended. To draw together all the interested workers from all parts of the county is so important an occurrence that the work taken up should be well considered and above the common-place.

In the furtherance of these plans and for the strengthening and unifying of methods in all departments of Grange work all over the State, early in the year county conferences were held, in which workers and delegates from every Grange met the State Grange Master or a member of the executive committee and discussed and adopted measures to improve ritualistic, parliamentary, educational, social and business methods inside each Grange.

The executive committee has had frequent meetings, and has a legislative committee from its members whose duty it is to keep in touch with similar committees appointed in each subordinate Grange, so that a complete system of machinery is established for the carrying into effect the determinations arrived at by the constant agitation and consideration of matters of public moment. The subject of taxation in all its phases may be said to be the major study at present of the local, county and State organizations, as one which directly affects the foundations of rural life.

The lecture field department has been strengthened materially under the efficient leadership of the present lecturer, Mrs. F. D. Saunders, who issues a monthly bulletin to the lecturers of subordinate and county Granges. This little regular visitor contains helpful editorials on the lecturers' opportunities and duties, and outlines of programs for their use if they so desire.

With the purpose in view of systematizing educational work, a text-book on civics has been recommended to be studied and made a basis for programs. As a result, scores of Granges are now pursuing the same line of investigation and program work with such variations interspersed as local tastes and conditions demand.

The work of State Grange week was divided among twenty-one committees made up of delegates. Besides matters having to do strictly with the regulation and conduct of affairs of the order, these committees dealt with the following topics of public interest, i. e., "Education," "Agricultural College and Institutes," "Agriculture," "Taxation," "Transportation" and "Pure Food." The Grange gave careful attention to the reports of all these committees, to the addresses and reports of its thirteen officers, and to the reports of its executive committee, and

the State committee on woman's work. Among the accomplishments of this last named committee, the one that yearly excites and enlists the utmost sympathy and interest is what is done in "Grange Fresh Air Work." The committee reports:

"Fifty-seven poor children and working girls have been given respite from homes of squalor and poverty to all the comforts and joys of two weeks of sunshine, fruit and flowers and of abundance in country homes. More than this, we can swell the numbers of those already adopted in former years to twenty-seven.

"This year three children have been adopted through the Fresh Air agency, all babies. If nothing else had been accomplished, this turning the current of three human lives, from the foul, stagnant stream of evil into which they would have in all probability drifted, into the clean strong life of a good home, has been worth every effort that has been made, and who can tell of what the harvest will be?"

The co-operative arm of the order has grown and is winning the confidence of Patrons and business houses by its simple plan of operation.

To the Patrons' Fire Insurance Companies in all of the stronger Grange counties of the State is no doubt due much of the present growth and success. Believing that extracts from the report of the committee on Grange insurance will be of value as well as of interest, they are herewith quoted:

"In reporting on Patrons' Mutual Fire Insurance, it would seem beneficial to look over the history of this line of work. In the East, notably in New York, they have been very successful.

"Profiting by their experience, the Patrons of Michigan are agitating and organizing these Patrons' Fire Insurance Companies, Lenawee county having the oldest; Hillsdale and a number of other counties have perfected or are perfecting their Patrons' Insurance Companies.

"It might be of value to compare the cost of insurance in the Lenawee Patrons' Insurance Company, carrying risks of one and a quarter million, with that of the Lenawee Farmers' Mutual, carrying risks of nearly ten million.

"While the cost in the old companies has been from $2 to $2.50 on a thousand, yearly, the entire cost in the Patrons' Mutual Fire Insurance Company during the two years and eight months of its existence has been only $1.30 per thousand. This cheap insurance we believe due to the following causes:

"First, to the excellent class of risks; second, to the machinery of our organization, thus saving excessive salaries; third, by having a local director in each subordinate Grange who can look after the risks in that locality, and lastly, bound by that fraternal feeling, the mutuality of the company is brought to its highest degree of perfection."

To give an exhaustive report of the year in Grange work in Michigan would require far more space than is here available, but these phases of the various departments have been briefly dwelt upon in order to show, if possible, the trend of the work being done that is placing Michigan only second or third in the list of strongest Grange states.

JENNIE BUELL,
Secretary.

Ann Arbor, Mich.

INDEX.

(9)

INDEX.

A.

B.

C.

D.

E.

F.

G.

H.

I.

K.

L.

M.

N.

P.

R.

S.

T.

V.

W.